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MAPPING & ANALYSING EUROPEAN RESEARCH & TECHNOLOGY INFRASTRUCTURES FOR ADVANCED MATERIALS UPTAKE

Independent Expert Report

Mapping & Analysing European Research & Technology Infrastructures for Advanced Materials Uptake

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Mapping & Analysing European Research & Technology Infrastructures for Advanced Materials Uptake

Technopolis Group, EFIS, GlassAI, Fraunhofer ISI, DTI, Tecnalia and Tekniker

2026 Directorate-General for Research and Innovation

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Abbreviations

AdMa – Advanced Materials
AM@ESP – Advanced Materials Spain Platform
ARIM – Advanced Research Infrastructure for Materials and Nanotechnology
BDIH – Basque Digital Innovation Hub
CAPEX – Capital Expenditure
CEA – Commissariat à l'Énergie Atomique et aux Énergies Alternatives (France)
CEZAMAT – Centre for Advanced Materials and Technologies (Poland)
DIH – Digital Innovation Hub
EDIH – European Digital Innovation Hub
EIB – European Investment Bank
EIT – European Institute of Innovation and Technology
EPPN – European Pilot Production Network
ESRF – European Synchrotron Radiation Facility
EU – European Union
GBER – General Block Exemption Regulation
ICTS – Unique Scientific and Technical Infrastructures (Spain)
IP – Intellectual Property
IPR – Intellectual Property Rights
KIT – Karlsruhe Institute of Technology
MERIL – Mapping of the European Research Infrastructure Landscape
NUTS – Nomenclature of Territorial Units for Statistics
OITB – Open Innovation Test Bed
OPEX – Operational Expenditure
R&D – Research and Development
R&I – Research and Innovation
RI – Research Infrastructure
RI&TI – Research and Technology Infrastructure
RPO – Research Performing Organisation
RTO – Research and Technology Organisation
SEP – Single Entry Point
SME – Small and Medium-sized Enterprise
SSbD – Safe and Sustainable by Design
TEF – Testing and Experimentation Facility
TI – Technology Infrastructure
TRL – Technology Readiness Level
UK – United Kingdom
US – United States

Abstract

This report presents the results of the study "Uptake of Advanced Materials," which provides a comprehensive mapping and analysis of the European landscape of Research and Technology Infrastructures (RI&TIs) focused on Advanced Materials. It builds on the European Strategy for Research and Technology Infrastructures and contributes to the preparatory work for the forthcoming Advanced Materials Act. The study identifies 2,943 AdMa RI&TIs across the EU, with Technology Infrastructures concentrated primarily in Western and Southern Europe, and oriented towards electronics, energy and mobility sectors. The EU's AdMa RI&TI landscape is benchmarked against infrastructures in Japan, the UK, and the US. In the EU, AdMa RI&TIs operate under diverse business models spanning the full TRL spectrum, offering services that extend beyond technological support. However, a number of structural gaps constrain the capacity of AdMa RI&TIs. Cross-border collaboration and industrial access remain limited in practice, hindered by fragmented funding landscapes, state aid constraints, administrative complexity and limited visibility of available capabilities, particularly affecting SMEs. The study's main recommendations include strengthening cross-infrastructure collaboration, notably with OITBs and EDIHs, and improving access conditions for SMEs through voucher schemes and targeted outreach, and developing a sustainable single-entry catalogue to enhance the visibility of the TI landscape. The study provides guidance for the development of this catalogue as a user-friendly, web-based platform with standardised service descriptions, intuitive filtering and a mixed funding model combining EU support with a gradual transition towards private revenue streams.

Ce rapport présente les résultats de l'étude « Adoption des matériaux avancés », qui fournit une cartographie et une analyse exhaustives du paysage européen des infrastructures de recherche et technologiques (IR&IT) axées sur les matériaux avancés. Il s'appuie sur la Stratégie européenne pour les infrastructures de recherche et technologiques et contribue aux travaux préparatoires du futur Acte sur les matériaux avancés. L'étude recense 2 943 IR&IT dans le domaine des matériaux avancés à travers l'UE, les infrastructures technologiques étant principalement concentrées en Europe occidentale et méridionale et orientées vers les secteurs de l'électronique, de l'énergie et de la mobilité. Le paysage européen des IR&IT est comparé à celui d'infrastructures analogues au Japon, au Royaume-Uni et aux États-Unis. Les IR&IT dans le domaine des matériaux avancés fonctionnent selon des modèles économiques diversifiés couvrant l'ensemble du spectre des niveaux de maturité technologique (TRL), offrant des services qui vont bien au-delà du soutien technologique pour inclure l'accompagnement entrepreneurial et écosystémique, la formation et le développement du capital humain, les positionnant ainsi comme des intermédiaires systémiques de l'innovation. Toutefois, un certain nombre de lacunes structurelles limitent la capacité des IR&IT dans le domaine des matériaux avancés. La collaboration transfrontalière et l'accès industriel demeurent limités en pratique, entravés par la fragmentation des paysages de financement, les contraintes liées aux aides d'État, la complexité administrative et la faible visibilité des capacités disponibles, affectant particulièrement les PME. Les principales recommandations de l'étude comprennent le renforcement de la collaboration entre infrastructures, notamment avec les bancs d'essai ouverts à l'innovation (OITB) et les pôles européens d'innovation numérique (EDIH), l'amélioration des conditions d'accès pour les PME par le biais de dispositifs de chèques-innovation et d'actions de sensibilisation ciblées, ainsi que le développement d'un catalogue à point d'entrée unique et durable afin d'améliorer la visibilité. L'étude fournit des orientations pour le développement de ce catalogue en tant que plateforme web conviviale, dotée de descriptions de services normalisées, de fonctionnalités de filtrage intuitives et d'un modèle de financement mixte combinant un soutien de l'UE avec une transition progressive vers des sources de revenus privées.

Executive summary

The study provides an overview of the European landscape of Research and Technology Infrastructures (RI&TIs) focused on Advanced Materials, builds on the European Strategy for Research and Technology Infrastructures and contributes to the preparatory work for the Advanced Materials Act.

Landscape of Research and Technology Infrastructures focused on Advanced Materials in the EU

- **The EU hosts 2,943 AdMa RI&TIs, with Technology Infrastructures representing around 36% of the facilities.** These infrastructures are concentrated in countries considered as innovation leaders, primarily in Western and Southern Europe (e.g., Germany, France, Spain, Italy), while Austria and Sweden show relative high density when normalised by population and GDP.
- **EU AdMa RI&TIs are predominantly oriented towards electronics, energy and mobility sectors, with relatively lower focus on medical devices and construction.** The infrastructures mainly focus on composites, semiconductors and metals, while smart, multifunctional and high-performance materials remain underrepresented.
- **More than 40% of surveyed AdMa RI&TIs are already working with Advanced Materials in defence or with dual-use applications, underlining their growing role in supporting EU strategic autonomy and the European Defence Technological and Industrial Base.** Working with Advanced Materials with potential dual-use applications poses specific challenges for RI&TIs. These challenges include more stringent technical requirements and specifications, as well as administrative and operational constraints such as security clearances.
- **AdMa RI&TIs operate under diverse business models reflecting their institutional missions, funding structures and positioning along the Technology Readiness Levels (TRL) spectrum.** RIs primarily focus on early-stage research and validation (e.g. TRL 1-3), while TIs address higher TRLs (e.g. TRL 4-8) through piloting, prototyping, testing and scale-up, together forming a continuum that supports the translation of Advanced Materials from scientific discovery to industrial deployment.
- **Most infrastructures combine public-mission research with market-facing services under public-private or mixed models**. Revenue sources include facility-as-a-service access, contract and collaborative R&D, open-access shared facilities, and, in some cases, product-centric manufacturing and licensing. This hybrid model enables TIs to serve both academic and industrial users.
- **RI&TIs also play a central role in human capital development, offering advanced training, doctoral and postdoctoral programmes, specialised technology courses and mobility schemes.** However, skills gaps and difficulties in attracting and retaining highly specialised staff constrain RI&TIs' capacity. Strengthening talent pipelines within RI&TIs is critical to ensure the EU’s competitiveness in AdMa.
- **AdMa RI&TIs address a broad range of user needs across the AdMa value chain**, notably in production technologies, decarbonisation, circularity, SSbD and zero-defect manufacturing. User needs are evolving rapidly towards integrated digital-physical services, including AI-driven design, digital twins, advanced characterisation and pilot-scale validation, particularly for SMEs facing cost and capability constraints.
- **The user portfolio of AdMa RI&TIs remains predominantly internal, with staff from host organisations representing the largest share of users across both RIs and TIs, indicating that most infrastructures continue to operate primarily as research assets**

rather than demand-driven service providers. While large enterprises and SMEs constitute a relevant external user group, particularly for TIs, industrial access remains moderate and uneven, suggesting that business access to AdMa RI&TIs is limited by several challenges.

- **Geographically**, AdMa RI&TI user engagement is largely regional and national, while cross-border European use remains limited and international users are marginal.
- **Several structural gaps constrain the capacity of AdMa RI&TIs to support innovation from early research to industrial deployment:**
  - **Limited availability (including lack of visibility and access barriers) of pilot-scale and pre-commercial production facilities across all analysed sectors**. This restricts the ability of users to validate materials at higher technology readiness levels and move beyond laboratory-scale experimentation. This limits the role of RI&TIs in bridging the "valley of death" between research and market uptake.
  - **Digital, AI and computational capabilities represent another major gap.** While Advanced Materials development increasingly relies on AI-supported design, modelling, simulation and automated experimentation, access to such tools remains uneven across the RI&TI landscape. Infrastructures lack integrated digital-physical workflows, advanced data management systems and interoperable platforms, constraining the uptake of digital twins, high-throughput experimentation and data-driven innovation.
  - **Further gaps exist in conformity testing, certification and regulatory support, particularly in application-driven and safety-critical sectors.** Insufficient availability of specialised testing services, such as for hydrogen technologies, medical applications, construction products and advanced electronics, leads to higher costs, longer time-to-market and dependence on non-EU facilities.
  - **Sustainability-related services also remain uneven**. Although user demand for circularity, environmental footprint assessment and Safe and Sustainable by Design (SSbD) methodologies is growing, RI&TIs lack systematic capabilities in recycled materials testing, life-cycle assessment, chemical safety and sustainability validation.
  - **System-level gaps persist in value-chain integration and coordination**. RI&TIs are often insufficiently connected to industrial ecosystems, start-up communities and downstream application developers. The absence of structured referral mechanisms, shared service frameworks and seamless user pathways limits users' ability to combine complementary capabilities across infrastructures. Strengthening cross-infrastructure coordination and bundling of RI&TI services would be essential to ensure that EU investments translate into deployable technologies, particularly in strategic sectors such as energy, microelectronics, mobility, bioeconomy and defence.

Overview of mappings and inventories identifying Research and Technology Infrastructures focused on Advanced Materials

- **RI&TI mapping is an important instrument to improve the visibility, accessibility and strategic coordination of the research and Technology Infrastructure landscape**. It supports scientific collaboration, industrial uptake, evidence-based policy planning and impact monitoring, while also informing on funding priorities by signalling which infrastructures are of strategic importance and where capability gaps exist. **Effective and functioning mappings/inventories can lower access barriers for industry, particularly SMEs, and can directly stimulate utilisation, innovation and return on public investment.**
- **The current AdMa mapping landscape is highly fragmented and dominated by organisation-level inventories, with fewer national and limited sustainable EU-level examples.** Most existing mappings do not clearly distinguish between RIs and TIs, reflecting

blurred operational boundaries. Filtering and search functionalities vary widely, and only a minority of platforms provide dedicated AdMa categories or robust multi-criteria filters, limiting their usability for industrial and cross-border users.

- **For most mappings/inventories, a key structural weakness is financial sustainability and regular maintenance, particularly at the EU level.** Many mappings are project-based and become outdated once the funding ends.
- Lessons learned point to the need for a more coordinated European approach in implementing mapping exercises. **Future EU-level activities should be based on long-term governance, integration with existing national inventories, clear scope definition and structured stakeholder engagement**.

Towards an accessible and sustainable RI&TI landscape for the uptake of Advanced Materials

- Access to AdMa RI&TIs is a key enabler of industrial innovation and EU competitiveness, as RI&TIs help companies, especially SMEs, to de-risk R&D processes by providing technology testing and validation services. These services are offered across all sectors of Advanced Materials.
- The AdMa RI&TI user access journey typically starts from awareness stages and progresses to negotiation, contracting and, finally, towards longer-term strategic partnerships and user retention. **Access is commonly governed through formal frameworks covering scope, confidentiality, IP, data protection, liability and fees.**
- Several challenges limit start-up and SME access to RI&TIs. These include:
  - **Limited awareness** of available TI capabilities at both the national and EU levels.
  - **Operational constraints**, scheduling capacity and safety or training requirements are often barriers, complemented in some cases by security checks, insurance requirements and nationality-related limitations driven by legal or geopolitical considerations.
  - **Affordability and administrative complexity**. Fees vary widely, often between €5k and €20k for services provided. While some RI&TIs offer reduced fees or help users navigate national and regional support, voucher schemes and dedicated access funding remain uneven and limited in coverage, creating persistent barriers to piloting and scale-up.
- **Measures to improve access** include:
  - Single points of contact, such as an industry liaison or a technology transfer unit.
  - Clearer service marketing and targeted outreach.
  - Reliance on regional innovation nodes and intermediary support through structures such as European Digital Innovation Hubs and regional technology centres.
  - Expanded financial support instruments, particularly vouchers designed to be state-aid compliant.

Funding, long-term sustainability and investments for setting up successful infrastructures

- To develop and upgrade their facilities, continuous CAPEX investments are necessary. Over the next five years surveyed AdMa TIs will need at least €0.9-€2.1b.
- **To finance the CAPEX in building and upgrading infrastructure, RIs more often rely on public funding, while TIs rely on a mix of funding sources, consisting of base and/or competitive public funding (regional or national), private funding, and public/loan models.**

- The **most widely used source of funding is regional or national public base or block funding** provided directly by governments. **Competitive public funding**, both at the EU and national/regional levels, also has an important role**. Income generated from the private sector** is generally less often used to finance CAPEX. Similarly, **financial instruments** such as loans or equity provided by banks or EU/national institutions **were largely not used by surveyed RI&TIs**.
- **The surveyed RI&TIs that focus on AdMa indicate that available funding for capital investment is not sufficient to address the upgrade needs.**
- The OPEX varies widely depending on the infrastructure type. Depending on their business model, AdMa RI&TIs cover a share of the operational costs using income generated from provided services. However, **only a handful of consulted AdMa RI&TIs can fully cover their operational expenses**. The remaining operational costs are covered by a mix of public and private funding and internal reserves of the organisation (e.g. reinvestment of profit).
- Despite the availability of non-competitive regional/national public base funding, AdMa RI&TIs indicated they face significant challenges related to covering OPEX. The challenges include low funding rates in national/EU and regional programmes, increased costs due to inflation and rising energy costs and insufficient demand to fully utilise the capacity of the infrastructures.

AdMa RI&TI collaboration modalities and guidance for increased collaboration

- AdMa RI&TIs collaborate with other RI&TIs, industry and other EU-level initiatives (e.g. OITBs, EDIH, Chip Pilot Lines) to progress technological research and development. To collaborate, RI&TIs employ several contractual models with external partners.
- **The most common form of collaboration is direct bilateral projects or contracts**. This suggests that one-on-one partnerships are the main model for collaboration, followed by **collaborative projects** within publicly funded programmes. **Long-term partnerships or collaboration agreements** are also widely adopted.
- **The challenges for the RIs and TIs collaboration include lack of stable and predictable funding, governance** (e.g. lack of harmonised IPR, data management, complex project administration), **access** (lack of harmonised rules and procedures across infrastructures and lack of knowledge of the RIs and TIs capabilities), **coordination and strategic alignment across funding and policy frameworks**.
- **The RIs and TIs collaboration could be strengthened** by combining service offering to companies, strengthening skills development, training and cross-learning, launching pilot collaboration projects, establishing shared guidelines, harmonised access rules and coordination mechanisms, improving mapping, coordination and strategic planning, developing new RI&TI links in industrial services provision, drawing on the geographical proximity effect, offering hybrid or co-financing schemes, including aligning multiple funding streams to enable RIs and TIs cooperation and using digital tools for remote collaboration.
- **The analysis of the TIs collaboration across borders** revealed that while the benefits of such collaboration are substantial (e.g. pooling resources to avoid duplication, enabling access to better, specialised and otherwise costly facilities to innovators, enhancing territorial cohesion), it has been rather limited in practice. Several challenges include fragmented and unsynchronised funding landscapes, state aid constraints and regulatory inconsistencies, competitive dynamics and limited incentives to collaborate, asymmetries in industrial capabilities and ecosystem maturity, limited knowledge of other TIs' capabilities and ecosystems and sensitivity of proprietary information and confidentiality requirements.
- **To strengthen and scale cross-border collaboration between TIs, the following measures should be pursued**: better coordination of funding instruments across regions and countries, engaging regional authorities and industry in joint TI investment planning,

fostering knowledge exchange and trust-building activities between TIs and clarifying IP ownership and data-sharing frameworks.

- The Open Innovation Test Beds (OITBs) are a form of TIs focused on Advanced Materials and are important players in the European R&I and industrial ecosystem. The OITBs bring together academia, Research and Technology Organisations (RTOs) and companies, in a consortium with a single-entry point (SEP). Nevertheless, **OITBs face several challenges related to their financial sustainability.** There is a limited industry demand for the offered services. Strengthening collaboration between RI&TIs and OITBs requires clearer strategic alignment, more explicit operational pathways and incentives that transform informal contacts into concrete joint activities. One recommendation is the creation of a joint roadmap to identify complementarities across RI&TIs and OITBs. More effective coordination mechanisms and governance structures are essential to overcome the persistent lack of time, motivation and formal mandate for cooperation. Improved communication and engagement across the ecosystem are equally important. A shared taxonomy for AdMa capabilities, services and use cases would enable actors in different countries and parts of the value chain to navigate more fluently.

- **European Digital Innovation Hubs (EDIHs) are EU, nationally and regionally funded support structures which provide digitalisation services to SMEs and the public sector.** EDIHs support AdMa development by assisting with the digitalisation of materials. Most hubs provide test-before-invest capabilities (pilots, proofs of concept, access to demonstrators and test beds, prototyping including additive manufacturing/3D printing, simulations and digital twins, and often HPC-as-a-service).

- **The most significant challenge faced by EDIHs relates to continuity of funding**. Interviewed EDIHs stated that their ability to support SMEs is highly dependent on ongoing funding from the EU/national governments. In terms of collaboration, several RI&TIs reported limited awareness of what EDIHs offer or how collaboration could be operationalised. In many cases, interactions have been restricted to promotional outreach or initial contact without progressing to joint activity. EDIHs could therefore benefit from clearer communication of their value proposition for AdMa, particularly regarding test-before-invest services, digital twins, modelling and simulation capabilities and access to digital infrastructures. Enhanced catalogue functionality, thematic mapping of EDIHs active in the sector and targeted brokerage or matchmaking events would help RI&TIs identify relevant hubs and concrete entry points for collaboration.

- **Regulatory sandboxes** are controlled experimentation schemes that allow innovators to test new products, services, or business models in the real world under a regulator's oversight. **Following the stakeholder consultation (interviews, survey and insights collected in the validation workshop), no cases of RI&TI focused on AdMa collaborating with regulatory sandboxes were observed.** Typically, the need to pilot the production and use of a novel material in a limited setting, even if certain safety regulations would normally classify that material in a way that makes it hard to use, is addressed by RI&TI facilities offering services at TRL 7-9. Nevertheless, regulatory sandboxes remain important in the field of production and use of AdMa.

Guidance for the development of a single-entry catalogue

- **A single-entry catalogue** has been proposed by the European Commission in the communication Advanced Materials for Industrial Leadership to provide guidance to companies on how to access existing Technology Infrastructures supported by the Commission and Member States, including also the services they provide. Work on this catalogue continues in alignment with the broader 2025 Research and Technology Infrastructures (R&TIs) strategy. Currently, a Horizon Europe CSA call has been launched on "Mapping and service finder for Technology Infrastructures (CSA)“, which will advance the creation of this resource.

- **In general, the catalogue should focus on listing Technology Infrastructures that provide services related to development, prototyping, testing, upscaling and validation**. The ability to include information in the catalogue should be accessible to all European TIs. The catalogue should contain clear, standardised, and comprehensive descriptions of infrastructure capabilities and services. These include: general information; technical capabilities and services, equipment specifications, performance parameters, material or service domains, and TRL coverage; information on related competencies and expertise offered by the RI&TIs; access conditions (incl. training requirements and IPR conditions), eligibility criteria and typical lead times should be included in the catalogue, including the indicative ranges or standard and specialised rates; application examples, use cases, case studies; financial support available (at regional, national and EU-level) to access each infrastructure.
- The information points listed above will have to be shared and regularly updated/reviewed by the RI&TI providers. However, lessons learned from multiple infrastructure mapping exercises show that this is a resource-intensive exercise. Therefore, **incentives supporting TIs in uploading the information and regularly updating the inventory will be critical.**
- **Achieving financial sustainability from the launch of the catalogue would be challenging**. Therefore, at first, a mixed funding model combining EU support and private funding should be established. This model should incorporate a gradual public funding phase-out process. The private funding element could be covered through measures such as a commission-based fee dependant on the type of services provided to industrial users; a fixed subscription-based fee where participation in the single-entry catalogue would be open to subscribed organisations.

1. Introduction

This report presents the findings and analytical insights gathered for the **Study on the Uptake of Advanced Materials,** which ran from June 2025 to February 2026. The sections below present the objectives, scope of the study and methodological brief, highlighting the approach to conducting the study.

1.1. Policy context

Advanced Materials are critical to the EU's industrial competitiveness, enabling the twin transition and underpinning key initiatives from the European Green Deal to the Zero Pollution Action Plan. Europe has taken coordinated steps to advance the sector[1]. By enhancing resource efficiency and enabling the substitution of scarce materials, AdMa play a vital role in achieving the EU's twin transition and in implementing key initiatives such as the European Green Deal[2], the Circular Economy Action Plan[3] and the Zero Pollution Action Plan[4], among others.

To maintain a global competitive advantage, Europe has made major strides in advancing the field of AdMa. In recent years, research organisations, industry, and policymakers have come together to shape a coordinated and forward-looking strategy for the sector, one that combines sustainability, innovation and industrial competitiveness.

In February 2022, research and industry joined forces to sign the **Materials 2030 Manifesto**[5] which then, involving EMIRI[6], EUMAT[7], MANUFUTURE[8] and SUSCHEM[9] Platforms led to **2030 Materials Roadmap** in December 2022[10]. While the former called for a coordinated approach to research and innovation (R&I) in AdMa, the latter defined a detailed plan of action to achieve the Manifesto's objectives. The Roadmap prioritised sustainability and resilience in materials development. It promoted eco-friendly innovations, emphasising recycling, reuse, and circular economy principles while also strengthening European value chains by reducing reliance on critical raw materials and enhancing supply chain stability. Finally, the **Strategic Materials Agenda** was released in April 2023[11], outlining specific actions to leverage game-changing technologies, create sustainable materials with circular business models, and foster innovation.

In 2024, the **EC Communication on Advanced Materials for Industrial Leadership**[12] set out the European strategy to ensure industrial leadership in AdMa.

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[1] Letta (2024) Much more than a market. Available at: https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf; Draghi (2024) The Future of European Competitiveness. Available at: https://commission.europa.eu/topics/strengthening-european-competitiveness/eu-competitiveness-looking-ahead_en#paragraph_47059

[2] Retrieved from: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

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[4] Retrieved from: https://environment.ec.europa.eu/strategy/zero-pollution-action-plan_en

[5] AMI2030 (2022) MATERIALS 2030 MANIFESTO Systemic Approach of Advanced Materials for Prosperity – A 2030 Perspective. Available online at: https://www.iam-i.eu/wp-content/uploads/2025/07/Materials2030Roadmap.pdf

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[8] Retrieved from: https://manufuture.org

[9] Retrieved from: https://suschem.org

[10] AMI2030 (2022) Materials 2030 Roadmap. Available online at: https://www.ami2030.eu/files/wp-content/uploads/2022/12/2022-12-09_materials_2030_roadmap_vf4.pdf

[11] AMI 2030 (2023) Strategic Materials Agenda. Available online at: https://www.ami2030.eu/files/wp-content/uploads/2022/12/2022-12-09_materials_2030_roadmap_vf4.pdf

[12] European Commission (2024), Communication on Advanced Materials for Industrial Leadership COM(2024) 98 final

One of the pillars of the Communication includes the creation of a **European Digital Infrastructure for AdMa R&I, known as "Material Commons,"** which builds on national initiatives. The Communication also indicates that a "**single-entry catalogue** will be launched online to provide guidance to companies on how to access existing Technology Infrastructures supported by the Commission and Member States, including also the services they provide".

In addition, a high-level group with representatives from the EU Member States, academia, industry, and other key players in research and innovation – the **Technology Council for Advanced Materials** – has been set up[13]. The Technology Council in 2025 established two time-limited subgroups focusing on the uptake & deployment of AdMa and future priorities for AdMa. The conclusions from the meetings of the subgroups are also key for guiding the Study.[14]

Looking ahead, the **forthcoming Advanced Materials Act** aims to strengthen the EU's research, innovation, and industrial capabilities, and reinforce its competitiveness in advanced materials to achieve open strategic autonomy. It will address key challenges such as value chain dependencies, the persistent gap between innovation and large-scale deployment, and the fragmentation of Europe's R&I ecosystem. The Act will help accelerate lab-to-market transitions, reduce reliance on critical external resources, and foster a more integrated and competitive sector, while promoting collaboration with like-minded partners to enhance supply chain resilience and reinforce Europe's global leadership in advanced materials.

Additionally, the European Commission announced in March 2024 the establishment of the **Innovative Materials for EU Partnership[15]** as part of Horizon Europe. This partnership, supported by initiatives such as the **Graphene Flagship[16]**, EUMAT, SUSCHEM, Manufuture and EMIRI, jointly formed the Innovative Advanced Materials Initiative: IAM-I[17], to address challenges spanning from design to recycling, aiming to ensure the sustainable lifecycle of AdMa. In February 2025, the IAM4EU released the **Strategic Research and Innovation Agenda (SRIA)[18]**. The document presents a structured roadmap that aligns material research with industrial needs, enabling a faster transition from laboratory discoveries to market applications.

In this context, RIs and TIs play a crucial, cross-cutting role in supporting Europe's transition towards a sustainable, digital, and resilient industry and society. To strengthen and better integrate these infrastructures into a truly European ecosystem, ensuring their long-term sustainability and greater impact, the European Commission has adopted the development of a European Strategy on Research and Technology Infrastructures.[19] The strategy sets out a comprehensive approach to strengthening this ecosystem, ensuring that infrastructures remain world-class, more accessible, and better aligned with the needs of scientists, innovators and industry. Key priorities include:

- Reinforcing the ecosystem by investing in building critical new capacities, mobilising investment through enhanced funding coordination and harnessing digitalisation and AI across infrastructures.

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[13] Retrieved from: https://research-and-innovation.ec.europa.eu/document/download/51afbb2e-bd2b-450c-aa5f-fab3840d9d1d_en

[14] Retrieved from: https://research-and-innovation.ec.europa.eu/document/download/895a178b-3826-4cdd-9109-e3a7116614ec_en & https://research-and-innovation.ec.europa.eu/document/download/9c492ad5-2c39-4d7c-a6cc-036828ea532a_en

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[16] Retrieved from: https://graphene-flagship.eu

[17] Retrieved from: https://www.iam-e.eu/

[18] Innovative Advance Materials for Europe (2025), The European Co-programmed Partnership, Strategic Research and Innovation Agenda. Available at: https://www.iam-i.eu/wp-content/uploads/2025/02/SRIA-Innovative-Advanced-Materials-for-Europe.pdf

[19] Retrieved from: https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/our-digital-future/towards-european-strategy-research-and-technology-infrastructures_en

- Facilitating and improving access so that scientists, researchers, and innovative companies, including start-ups and scale-ups, have more opportunities to use cutting-edge facilities and services across Europe.
- Attracting and developing talent from managers and technical specialists to scientific leaders and innovators.
- Improving governance to support long-term investment, align national and European priorities, and increase the impact of public funding.
- Strengthening international cooperation and resilience, enhancing Europe's sovereignty in critical research data and reinforcing its position in science diplomacy.

The strategy builds upon previous policy actions, including the revised EU State Aid rules applying to Research and Innovation, introduced concept of "Testing and Experimentation Infrastructures"[20], efforts of the Commission Expert Group on TIs[21], and other high-level reports (Draghi[22], Heitor[23] and EC Communication on the Competitiveness Compass[24] for the EU) showcasing the importance of RI&TIs in the EU R&I landscape[25].

Finally, in the current geopolitical context, two reports "**Making the most of EU Research and Innovation Investments: rethinking dual use**"[26] and "**Unlocking the potential of dual-use research and innovation**"[27] highlight the strategic role of dual-use R&I funding to foster security, strategic autonomy, competitiveness and sustainability and offer concrete examples and case studies on how dual-use R&I can work in practice. Following these reports, the Study will inform on RI&TIs focused on AdMa working with the defence sector.

1.2. Objectives and scope of the study

The study informs on the European landscape of Research and Technology Infrastructures (RI&TIs) focused on Advanced Materials, builds on the European Strategy for Research and Technology Infrastructures and is part of the **preparatory work** for the **Advanced Materials Act.** The latter is a flagship initiative that will provide the framework conditions to support the entire lifecycle of Advanced Materials, from research and innovation to start-up creation, manufacturing, and deployment[28].

The objective of this study was to collect evidence and analyse the RI&TI landscape in the field of Advanced Materials.

The specific objectives of the study were to:

[20] Communication from the Commission Framework for State Aid for research and development and innovation 2022/C 414/01, https://eur-lex.europa.eu/legal-content/EN/TXT/%2803%29

[21] Retrieved from: https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?lang=en&groupID=3928&fromCallsApplication=true

[22] Retrieved from: https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en

[23] Retrieved from: https://efmc.eu/wp-content/uploads/2024/11/241119-Heitor-report-of-30-September-2024-Align-Act-Accelerate.pdf

[24] Retrieved from: https://commission.europa.eu/topics/eu-competitiveness/competitiveness-compass_en

[25] Retrieved from: https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en#paragraph_47059 ; https://op.europa.eu/en/publication-detail/-/publication/2f9fc221-86bb-11ef-a67d-01aa75ed71a1/language-en ; https://commission.europa.eu/document/download/10017eb1-4722-4333-add2-e0ed18105a34_en

[26] European Commission: Directorate-General for Research and Innovation, Making the most of EU research and innovation investments – Rethinking dual use, Publications Office of the European Union, 2025, https://data.europa.eu/doi/10.2777/6637451

[27] European Commission: Directorate-General for Research and Innovation, Unlocking the potential of dual-use research and innovation, Publications Office of the European Union, 2025, https://data.europa.eu/doi/10.2777/5771805

[28] A Competitiveness Compass for the EU. Retrieved from: https://commission.europa.eu/document/download/10017eb1-4722-4333-add2-e0ed18105a34_en

- **Map and analyse the available RI&TIs and their business models in the EU** which provide services beyond their local ecosystem in the field of Advanced Materials and **focus on supporting the development of breakthrough technology and their production and scale-up**.
- Assess the **current state of the research and Technology Infrastructure landscape** in the field of Advanced Materials in the EU, across the different priority sectors.
- Identify Member States which have carried out/are carrying out their own mappings of RI&TIs covering this field.
- **Identify (industrial) users' needs**, especially for innovative SMEs and start-ups, for types of services offered by RI&TIs, their accessibility to users, including the affordability of fees paid by users.
- **Identify and assess the existing gaps and overlaps** in the current landscape of RI&TIs in the field of Advanced Materials.
- **Analyse the collaboration patterns for these infrastructures**, including with European Digital Innovation Hubs (EDIHs) and OITBs, as well as with regulatory sandboxes more specifically, among other EU and national initiatives (incl. Testing and Experimentation Facilities (TEFs), chips pilot lines, etc.), and provide good practices and guidelines.
- **Provide guidance on the development of a neutral and sustainable single-entry catalogue** for RI&TIs with the aim of facilitating access to users and encouraging networking among infrastructures.
- Consider the use and further deployment of the catalogue within the context of other European Commission initiatives, such as the forthcoming European Innovation Platform.
- Provide **examples stemming from the RI&TIs landscape of three third countries** - Japan, the UK and the US – that contribute to the relevant dimensions covered by this study.

In terms of scope, the study was based on the following definition of RI&TIs:

- **Research infrastructures (RIs)** are facilities that provide resources and services for the research communities to conduct research and foster innovation in their fields.[29] While typically, RIs are closer to universities and lower technology readiness levels (TRL) activities, some RIs also work with industry[30], pointing to their role in technology uptake.
- **Technology Infrastructures (TIs)** are defined as "public, semi-public or private facilities, equipment, capabilities and support services required to develop, test and upscale technology to advance from validation in a laboratory up to higher TRLs prior to competitive market entry. The TI users are mainly industrial players, including SMEs, which seek support to develop and integrate innovative technologies towards commercialisation of new products, processes and services, whilst ensuring feasibility and regulatory compliance". In addition to this definition, a 2024 study on the landscape of TIs[31] found that the concept encompasses a wide nomenclature of related terms, such as (open innovation) test beds

[29] These include: 1) major equipment or sets of instruments; 2) knowledge-related facilities such as collections; 3) archives or scientific data infrastructures; 4) computing systems; 5) communication networks.
[30] ESFRI RIs and is also highlighted in the Council Conclusions on Research Infrastructures (adopted in December 2021)
[31] European Commission: Directorate-General for Research and Innovation, Viscido, S., Strauka, O. and Coroler, E., Policy landscape supporting Technology Infrastructures in Europe – Final report, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2777/504517

(OITBs), testing and experimentation facilities, innovation infrastructures, “pilot lines”, technology platforms, living labs, and (pilot) demonstrators.[32]

While the study focused on both RIs and TIs, in some cases (e.g. access modalities, type of services offered, CAPEX funding needs), specific focus has been placed on TIs. By doing this, the study team recognises the complementary yet different focus and role in the ecosystem of RIs and TIs. The presented results specify when the focus is placed on TIs only or covers both RI&TIs.

Geographically, the study adopted a multi-level approach, covering the EU, national and regional level of EU countries, as well as three benchmark countries: Japan, the UK and the US.

1.3. Analytical approach, methodology

The analytical framework used for the comprehensive assessment of the AdMa RI&TI landscape in the EU is based on a four-step approach: **mapping, trends and needs analysis, gap analysis**, and identification of good practices and **formulation of conclusions and recommendations.**

Step 1 - Mapping phase: the mapping phase is structured around five main pillars:

- **Landscape of AdMa RI&TIs in the EU**: examining geographic coverage, including the number of RI&TIs per region, co-location with industrial users, types of operators, and portfolio size.
- **Business model & service offering**: assessing the technology focus (e.g. types and functionalities of materials processed, and equipment provided), service offering and range of technology readiness levels, users’ needs addressed, etc.
- **Users & accessibility conditions**: exploring user types and distribution, access modalities, cost structures and fee affordability, to determine how effectively RI&TIs meet user needs and the challenges that remain.
- **Funding levels, sources & needs**: assessing current funding scales, operational cost coverage, future investment needs, and the diversity of funding sources.
- **Networks, catalogues and collaboration**: analysing existing RI&TIs catalogues, network involvement, and collaboration patterns with initiatives such as OITBs, EDIHs, and regulatory sandboxes.

An additional pillar focuses on **third-country benchmarking** of the AdMa landscape in Japan, the UK, and the US. The objective was to identify best practices and opportunities for improving the EU’s AdMa RI&TIs landscape.

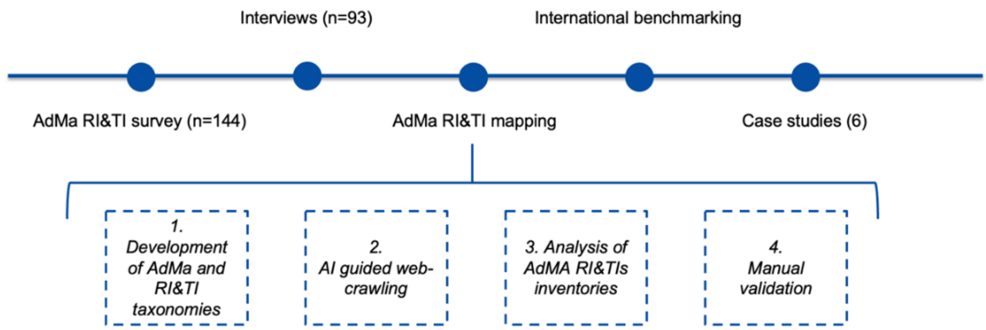
Step 2 – Trends, needs and gap analysis: involved synthesising trends and stakeholder needs through a triangulation of data from desk research, web crawling, questionnaires, and interviews.

Step 3 – Good practices, recommendations and guidance notes: identification of good practices and derived strategic and operational conclusions and recommendations, which were validated in a stakeholder workshop.

The figure below provides an overview of the key methods used and the number of consulted stakeholders.

[32] European Commission: Directorate-General for Research and Innovation, Viscido, S., Strauka, O. and Coroler, E., Policy landscape supporting Technology Infrastructures in Europe – Final report, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2777/504517

Figure 1 Overview of methods used and consulted stakeholders.



Source: Technopolis Group

More specifically:

- **Desk research**: consisted of three main sub-tasks. The first was the identification of existing AdMa RI&TIs mappings. The second sub-task was stakeholder mapping and the identification of RI&TI providers. Finally, the third sub-task focused on collecting information on the AdMa RI&TI landscape for international benchmark cases, specifically from Japan, the UK, and the US.
- **AdMa RI&TI survey**: focused on collecting qualitative and quantitative data relevant for the needs and gap analysis. In total, 144 responses covering RI&TI services, funding models and access conditions were received. The results summarise key respondent characteristics, along with comparative insights by region, technology domain, or organisational structure, as well as a summary of open-ended responses capturing investment needs, operational challenges, and barriers to accessing RI&TIs, which are presented in the report below.
- **Interviews**: The objectives of this interview programme were to validate and deepen the study's evidence base by complementing the collected data with additional insights to address potential data gaps and refine the understanding of AdMa RI&TIs in each Member State. The activity also aimed to obtain multiple stakeholder perspectives from the AdMa RI&TI ecosystem, including policy makers, RI&TI operators, OITBs/EDIHs, and RI&TI users, particularly SMEs. In addition, insights from the interviews were used to inform the development of the single-entry catalogue and provide guidance towards facilitating more effective collaboration with OITBs, EDIHs, regulatory sandboxes, and other related initiatives. In total, 108 interviews were carried out.
- **AdMa RI&TI and their potential user mapping**: The study team has mapped AdMa RI&TIs by carrying out AI-guided web crawling analysis. In addition, potential AdMa RI&TI users were identified using patent analysis and active companies and start-ups in AdMa. More information is available in Appendix B.
- **International benchmarking**: to complement and compare the EU analysis with the situation in Japan, the UK, and the US, data was collected through desk research, web crawling, and interviews. The international benchmarking also sought to identify good practices in these three countries.
- **Case studies**: in total, six in-depth case studies were prepared focusing on AdMa RI&TI collaboration, cross-border TIs collaboration and collaboration between EDIHs and OITBs.

In addition, other case studies focused on AdMa RI&TI access conditions and modalities and lessons learned from AdMa RI&TI inventories.

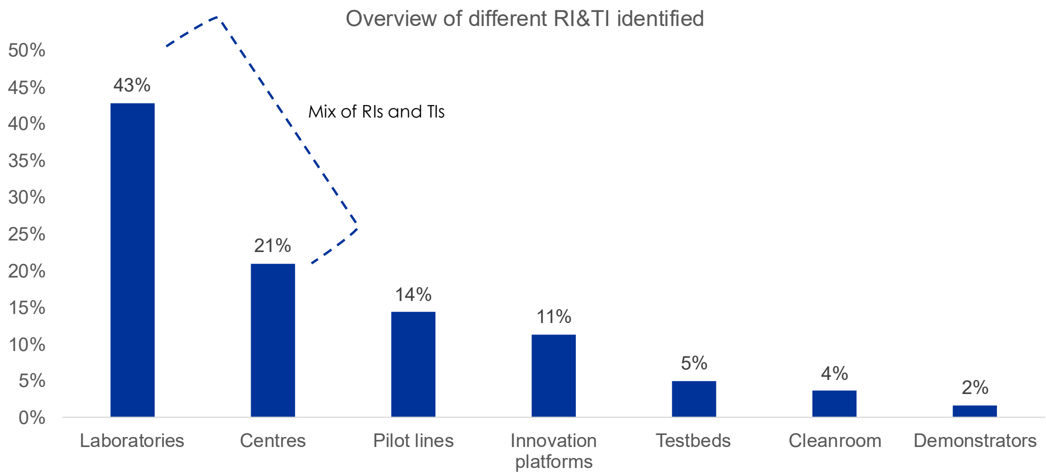
- **Validation workshop**: an online validation workshop was organised to present and validate the study's findings.

2. Research & Technology Infrastructure landscape in the field of Advanced Materials

2.1. AdMa RI&TI landscape

In total, 2,943 AdMa RI&TIs were identified across the EU. As the figure below shows, most infrastructures are classified as laboratories (including living labs) and centres (such as technology centres). In line with the European RTI strategy, TIs include pilot lines, plants, innovation platforms, test beds, cleanrooms, and demonstrators. These **TIs account for 36% of all identified RI&TIs. However, this proportion is likely an underestimate, as many laboratories and centres also provide services that align with the functions typically offered by TIs.**

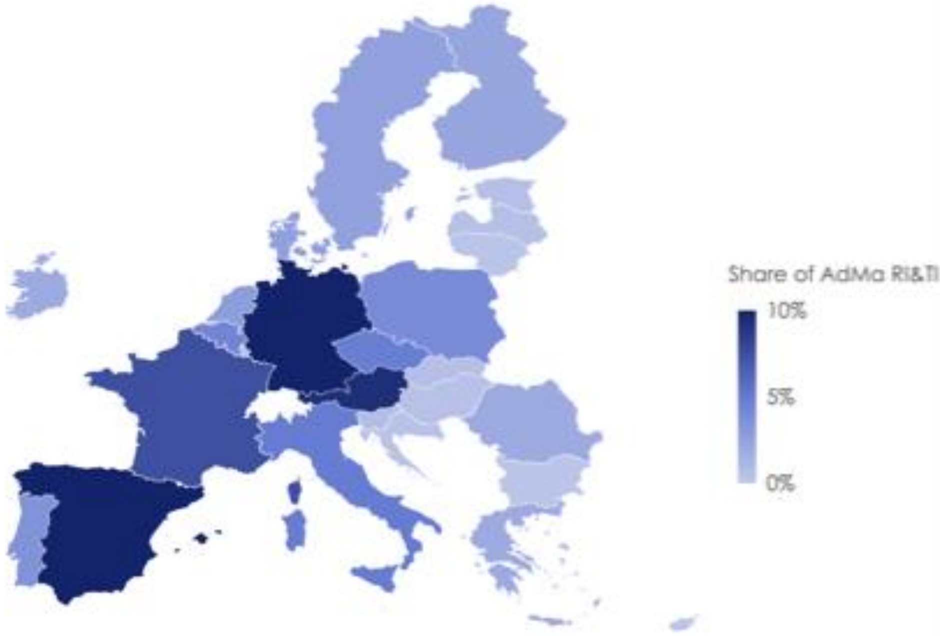
Figure 2 Overview of different RI&TIs identified.



Source: Technopolis Group. Results based on web-crawling analysis and 2,943 AdMa RI&TIs.

RI&TIs focused on AdMa are concentrated in Western and Southern Europe, notably Germany, Spain, Austria and France, (see figure below). Together, these four countries account for more than half of all identified TIs, indicating their leading role in the sector's development. **Italy and Belgium also have notable shares**, reflecting the presence of consolidated industrial and research ecosystems. **Sweden, Denmark, Finland, the Netherlands and Ireland also host a significant part of the AdMa RI&TIs.**

Figure 3 Distribution of AdMa RI&TIs across the EU.



Source: Technopolis Group. Results based on web-crawling analysis and 2,943 AdMa RI&TIs.

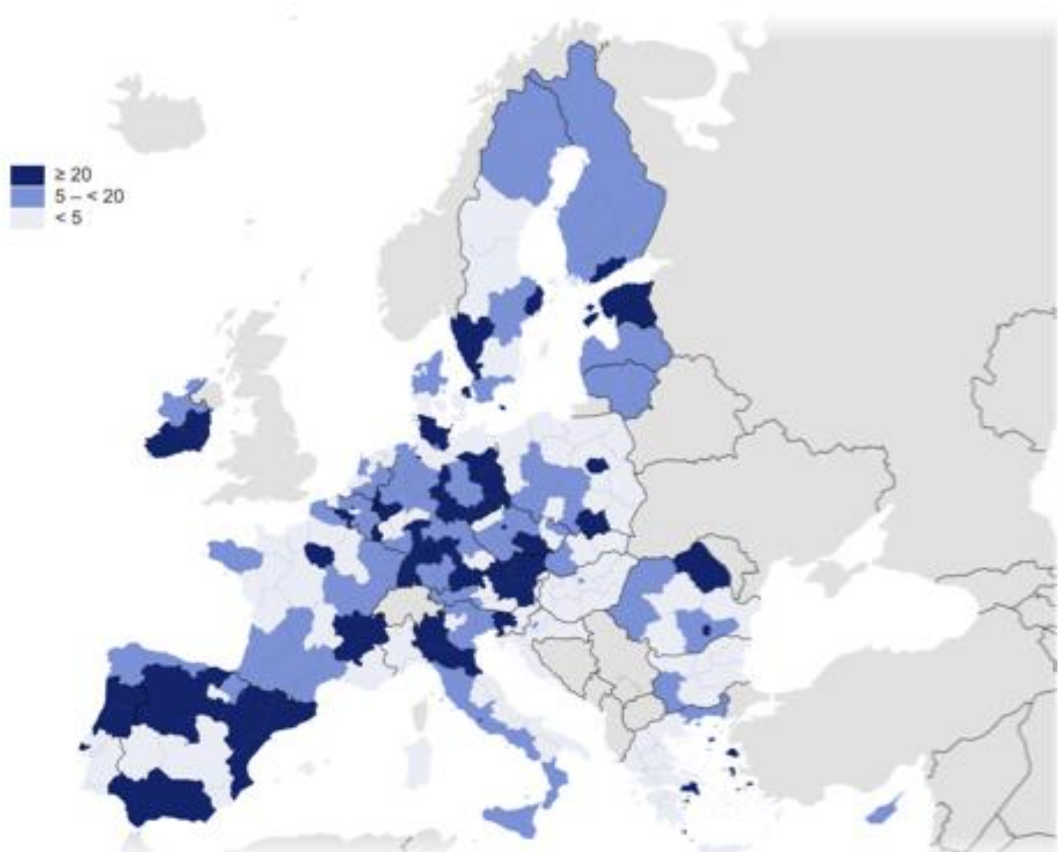
To take account of the country size, the distribution of AdMa RI&TIs was normalised by:

- **Population. Austria, Luxembourg, Estonia, Denmark, Czechia and Finland** have a high density of AdMa RI&TIs relative to population (million inhabitants) size. Hence, population size does not constrain the relative potential to engage in AdMa research and innovation, for instance, Luxembourg, despite its small size, has a notable presence in AdMa RI&TIs.
- **Gross Domestic Product (GDP).** When the number of AdMa RI&TIs per €10b GDP is considered, Austria, Estonia, Czechia, Latvia, Slovenia, Spain, Greece and Finland have a high density of AdMa RI&TIs. Despite a high absolute number of AdMa RI&TIs, Germany, the Netherlands, France and Italy have a lower density of infrastructures per GDP.

At the regional level, the data indicate that AdMa **RI&TIs are concentrated in regions identified as strong or leading innovators as classified by the European Regional Innovation Scoreboard**[33]. The map below illustrates the distribution of AdMa RI&TIs across EU regions at the NUTS-2 level. The darker shades of blue represent regions with a higher number of AdMa RI&TIs, while lighter shades indicate fewer such infrastructures.

[33] Retrieved from: https://projects.research-and-innovation.ec.europa.eu/en/statistics/performance-indicators/european-innovation-scoreboard/eis#/ris?compare_year=2025

Figure 4 Distribution of AdMa RI&TIs across EU, regional NUTS2 level overview (values in the legend indicate the number of AdMa RI&TIs per region).



Source: Technopolis Group. Results based on web-crawling analysis implemented by GlassAI. The distribution is based on 2,943 AdMa RI&TIs.

The regional distribution indicates relatively **high AdMa RI&TI concentration** in Oberbayern, Stuttgart, Karlsruhe, Darmstadt, Köln, and Dresden (Germany), Ile-de-France, Rhône-Alpes and Provence-Alpes- Côte d'Azur (France), Spain (especially the Basque Country and Catalonia), Portugal (Grande Lisboa, Norte), Wien, Niederösterreich and Steiermark (Austria). These areas are characterised by established industrial ecosystems, dense networks of universities and R&D centres, and strong public-private partnerships. **Moderate concentrations are visible in several regions** across Romania (Nord Est, Bucharest), Czechia (Praha and Jihovýchod), Poland (Mazowieckie and Śląskie), Greece, Croatia and the Baltic states.

2.1.1. Sectoral and materials focus of AdMa RI&TIs in EU 27

Regarding vertical sectors of application, EU RI&TIs are primarily oriented towards electronics (42%), energy (30%) and mobility (13%), while relatively few focus on medical devices (10%) and construction (4%). In terms of horizontal sectors of application, RI&TIs most commonly address materials characterisation (46%) and the manufacturing of AdMa (28%). Least common are RI&TIs supporting safe and sustainable design (5%) and the digitalisation of AdMa (3%).

Among functionality types addressed by RI&TIs, chemical (17%), conductive (13%), and mechanical and structural (11%) functionalities are the most represented. The least frequent are smart and multifunctional materials (2%) and high-performance materials (1%). An overview of AdMa RI&TIs per main sector of application across the EU is also available in Appendix D.

EU AdMa RI&TIs address a range of material types. By far the most common material type is composites (29%). A recent JRC report also showed that, based on patent share and Technological progression probability (TPP) analysis, the EU is currently strong in composites and will likely consolidate its strength in the future[34]. Semiconductors and superconductors (15%) and metals (13%) are also well represented. Least frequent are ceramics (8%) and quantum dots (5%).

2.1.2. Defence and dual use focus of AdMa RI&TIs in EU 27

AdMa are a critical enabler of defence capability, as they underpin performance, resilience, and cost-effectiveness across platforms and systems. For the EU, they are central to achieving strategic autonomy and strengthening the European Defence Technological and Industrial Base (EDTIB), reducing reliance on non-EU suppliers in key value chains such as aerospace, electronics, energy, and protective systems. AdMa also accelerate innovation in priority domains such as next-generation aircraft, space, cyber-physical systems, and sustainable defence technologies, while improving interoperability and lifecycle efficiency across Member States, positioning the EU to respond more effectively to evolving security and geopolitical risks.

Testing and accelerating AdMa are essential to shorten time-to-deployment and ensure that innovations can be rapidly translated from research into operational capabilities. Pilot lines, digital simulation, and shared test infrastructures help scaling up the production and enable faster industrial uptake, reduce development costs, and strengthen the EU's ability to keep pace with technological and strategic competitors.

Recent EU policy initiatives and strategic documents reflect the strategic importance of TIs in defence innovation. In particular, the European Commission's *EU Defence Industry Transformation Roadmap* emphasises that testing and validation are essential steps for bringing new defence technologies to operational readiness, while noting that access to testing infrastructure remains constrained and cross-border mobility limited, particularly for SMEs and new entrants. **The Roadmap therefore proposes measures to facilitate faster and wider access to facilities in the EU, complementing the existing EU network of testing facilities**.[35]

In parallel, recent changes to EU funding rules indicate a positive development for AdMa RI&TIs active in dual-use and defence domains. As part of legislation adopted by the European Parliament in December 2025, the EU will enable a greater share of EU funding to be directed towards defence-related investments by amending the rules governing existing EU programmes, including Horizon Europe, the Digital Europe Programme, and the Strategic Technologies for Europe Platform (STEP).[36] For RI&TIs active in defence-relevant domains, this policy change implies that R&I activities related to materials development with defence or dual-use applications may now be eligible for EU research and innovation funding, provided they comply with the respective programme rules and objectives.

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[34] ALBORA, G., BENOIT, F., CALDAROLA, B., DI GIROLAMO, V., DIODATO, D. et al., Path to innovation: an Economic Complexity analysis of technological perspectives in the EU - Advanced Materials, Publications Office of the European Union, Luxembourg, 2025, https://data.europa.eu/doi/10.2760/6124424, JRC144431.

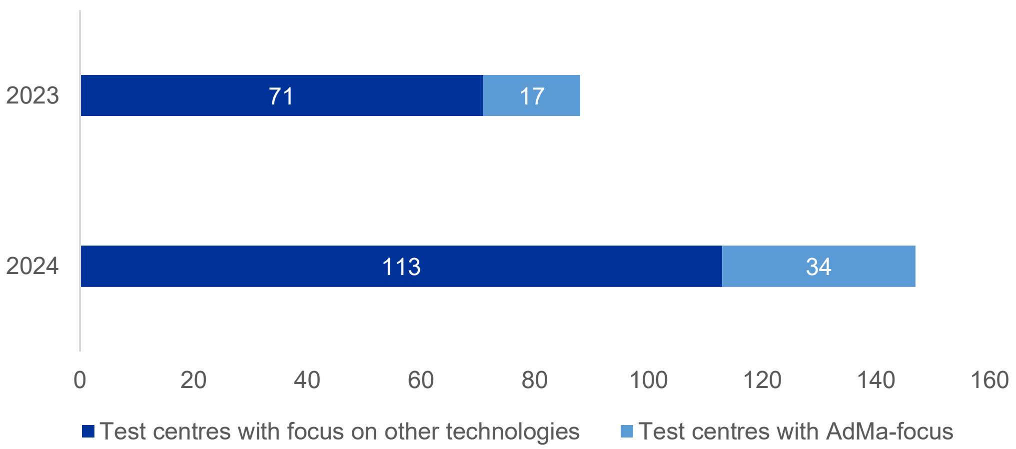
[35] Retrieved from: https://defence-industry-space.ec.europa.eu/document/download/513de692-d08c-40cc-80c3-cb6611ace178_en

[36] Retrieved from: https://www.europarl.europa.eu/news/en/press-room/20251211IPR32157/parliament-backs-measures-to-boost-eu-support-for-defence-investment

In terms of scale, more than 40% of surveyed AdMa RI&TIs are already developing AdMa for dual-use and defence applications. Moreover, interviewed RI&TIs indicated that they have started to work on dual-use recently (over the past 3 years). Examples include coatings for low observability, light-weight materials for aerospace applications, ceramics for ballistic protection, biopolymers for battlefield dressings, membrane for personnel protection, alloys for military vehicles, composite materials for drones and ships, and transparent ceramics for protective optical windows.

Further insights on the scale and distribution of defence and dual-use-oriented AdMa RI&TIs in the EU can be derived from the test centre network of NATO's innovation accelerator, DIANA (Defence Innovation Accelerator for the North Atlantic). DIANA operates test centres spread across NATO member countries, encompassing private companies to public research institutes or universities. While not exhaustive, the composition of this network provides a useful proxy indicator for estimating the presence of AdMa RI&TIs active in defence-related and dual-use applications within the EU. The number of DIANA's test centre network expanded significantly from 11 to 23 accelerator sites and from 90 to 182 centres in 28 allied countries in 2024. The figure below provides an overview of the centres located in the EU, distinguishing between those with and without an AdMa focus.

Figure 5 DIANA's test centres located in the EU with a focus on AdMa.



Source: Technopolis Group (2025) based on DIANA Test centre network.

Out of the 182 DIANA test centres operational in 2024, 147 are in the EU. Further analysis indicates that 34 of these centres have a focus on AdMa. This represents a twofold increase of the RI&TIs focused on AdMa compared to 2023. It should be noted that registered centres typically represent the operator of RI or TI. Examples of operators that manage TIs include the DTU NanoLab, Fraunhofer IAF (Institute for Applied Solid State Physics), and Tartu University.[37]

Participation in European defence research frameworks also provides additional information. In this regard, initiatives under the European Defence Agency (EDA) Capability Technology (CapTech) group on Materials and Structures ("Materials CapTech") provide insights on the involvement of AdMa RI&TIs in dual-use–relevant activities. The Materials CapTech supports collaborative R&D activities addressing capability needs related to materials and structures for European armed forces.[38] RI&TIs that have participated in these activities include, for example, TNO, which has contributed to a project developing camouflage of land

[37] Retrieved from: https://www.diana.nato.int/resources/site1/general/test%20centres/20250826_diana-affiliated-network-test-centres_.pdf
[38] Retrieved from: https://eda.europa.eu/what-we-do/all-activities/activities-search/captech-materials-structures

systems using smart and adaptive materials.[39] Politecnico di Milano which worked on a project to develop the design of composite low noise naval propellers[40], while INEGI is part of a working group to research lightweight, high-performance materials for military equipment.[41]

TIs play an important role in defence-related R&D as the above examples illustrate, but consulted TIs indicate that R&D services related to defence and dual-use applications differ from, and are generally more demanding than, purely civilian R&D. Reported challenges include stringent technical requirements and specifications, as well as administrative and operational constraints such as security clearances.

2.2. Business & service delivery model

2.2.1. AdMa RI&TIs business models

While **RIs typically operate at lower to mid technology readiness levels (TRLs), focusing on fundamental research, material discovery, and early-stage validation (TRL 1-4), TIs, in contrast, address higher TRLs (TRL 4-8), providing pilot lines, prototyping, testing, and scale-up capabilities needed to bridge the gap between laboratory results and industrial deployment.** Together, RIs and TIs form a continuum that accelerates the transition of AdMa from scientific innovation to market-ready product/solution.

RIs and TIs in AdMa operate under diverse business models that reflect their different institutional missions, funding mechanisms and the maturity levels of the technologies they support. These models include :

- **Public mission / academic core**: this operational model is typical for traditional RI and universities whose primary mandate is research activities. Main revenue streams include base funding and funding from national/EU projects.
- **Public–private (mixed) model**: this model is the traditional model adopted by RTOs. Under this model, RI&TIs that combine publicly funded research with market-facing services for industry, through a mix of grants, contract research, joint projects, pilot testing and technology transfer. Main revenue streams include:
  - **Rental, access, and facility-as-a-service**: based on users renting time, space, or equipment within a RI&TI, often bringing their own staff while receiving supervision and optional expert support. These models typically operate through time-based access to specialised equipment, supervised operation, and in some cases embedded teams working on site. Revenue is generated through rental fees, training services, and ancillary offerings such as testing, certification, and design-stage validation.
  - **Contract R&D and collaborative project-based models**: focus on delivering research and development through projects with industrial and academic partners. These operate via bilateral contracts or larger consortium projects funded at national or EU level, with infrastructures providing scientific and technical expertise. Revenue streams mainly come from project budgets, direct industrial contracts, and long-term strategic partnerships.
  - **Production and product-centric models:** infrastructure capabilities are used to directly manufacture components or products, such as specialised ceramics or advanced therapy medical products. In this model, the infrastructure operates in-house manufacturing

[39] Retrieved from: https://eda.europa.eu/docs/default-source/documents/eda-ascals-d1400-executive-summary-of-ascals-i-(1).pdf
[40] Retrieved from: https://eda.europa.eu/docs/default-source/documents/nextprop---executive-summary.pdf
[41] Retrieved from: https://www.inegi.pt/en/news/inegi-is-working-with-the-european-defence-agency-to-develop-new-materials/

under its own brand or on behalf of clients, supplying domestic and international markets and sometimes producing demonstration products. Revenue is generated through product sales, technology licensing, and contract manufacturing.

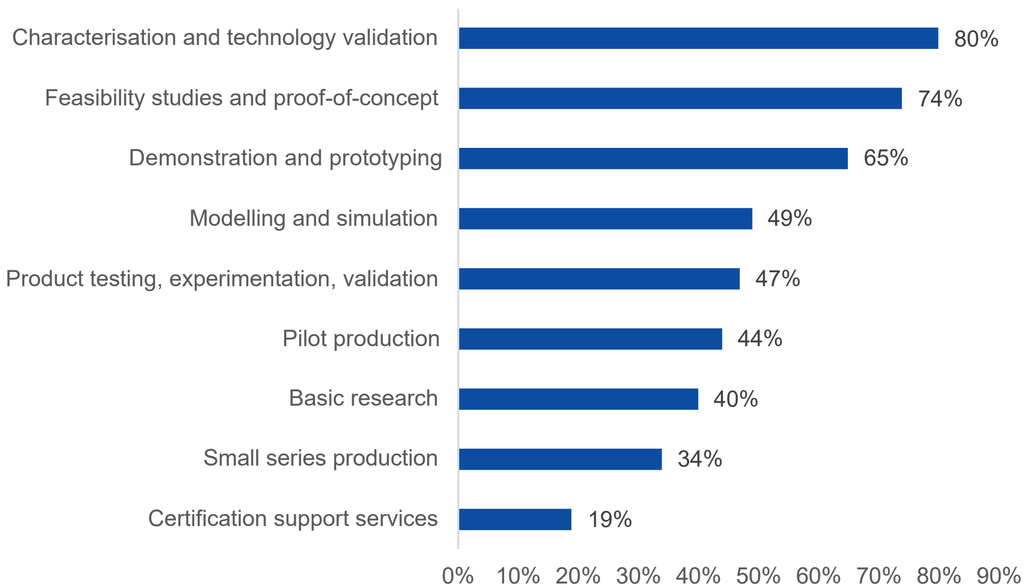
- **Open-access models**: based on shared TIs that support scale-up, pre-series production, and de-risking services in areas such as plastronics, foam forming, atomisation, or graphene. External users access equipment under service agreements that are often supported by public funding, while infrastructure staff provide technical and process support.

2.2.2. AdMa RI&TIs services and strategic positioning

RI&TIs active in the field of AdMa provide a broad range of services that span the entire innovation spectrum from fundamental analysis to pilot-scale production and industrial validation. Their service portfolios are closely aligned with their missions, funding models and the maturity of the technologies they support. **The main categories of services can be grouped as follows: analytical and characterisation services, testing and certification, materials development and prototyping, collaborative R&D and feasibility studies, and knowledge sharing and technical support.**

Focusing on TIs, the survey results indicate that infrastructures most frequently provided testing, characterisation and technology validation services (80%), as well as feasibility studies and proof-of-concept (74%) and demonstration and prototyping services (65%).

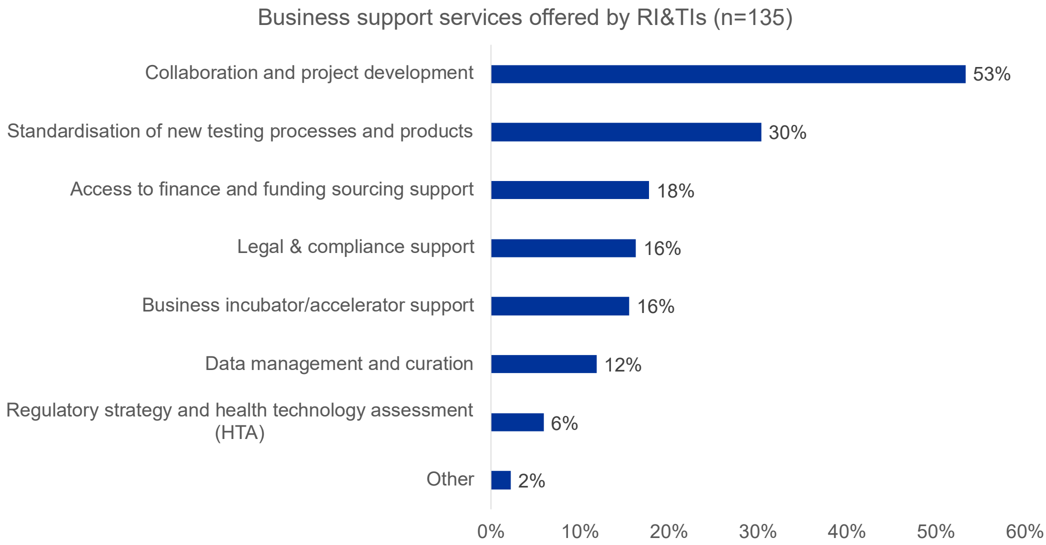
Figure 6 Technology services offered by surveyed AdMa TIs.



Source: Technopolis Group (2025) based on results from RI&TI AdMa mapping survey. Values do not add to 100% due to multiple-choice answers.

In addition to technological services, 75% of surveyed RI&TIs also provide business support services. **Thus, the role of AdMa RI&TIs extends beyond the technology services, towards business, ecosystem support and skill building**. By far the most common type of support is collaboration and project development (53%), though many RI&TIs also frequently provide support with standardisation of new testing processes and products (30%).

Figure 7 Business support services offered by surveyed AdMa RI&TIs.



Source: Technopolis Group (2025) based on results from RI&TI AdMa mapping survey. Values do not add to 100% due to multiple-choice answers.

In terms of certification and standardisation services, based on the survey results, they are typically provided by TIs focused on AdMa. The table below provides examples of the standardisation and certification services provided by TIs in AdMa and regulations (both national and EU addressed).

Table 1 Examples of the standardisation and certification services provided by TIs in AdMa and regulations (both national and EU addressed)

Sector	Certification and standardisation services (examples)	National and EU level regulations addressed
Energy	• Battery performance, safety, and lifecycle testing (e.g. IEC 62660, UN 38.3) • Certification of components for hydrogen, CO_2, and PtX systems (e.g. ASME B31.12, ISO 15105-1) • Accredited testing of biomass boilers and wood-burning stoves (e.g. DS/EN 303-5, EN 13240) • Factory/site acceptance testing of battery energy storage systems • Certification of energy reviews (ISO 50002, SS-EN 16247) • Accredited testing of inverters (IEC 62109, IEC 61727)	National: • Swedish law on energy reviews in large companies (EKL 2014:266) • Danish Energy Technical Regulation 3.3.1 EU: • EU Battery Regulation (safety, performance, sustainability requirements). • EU Ecodesign Regulations and Energy Labelling Regulations (product

	• Certification and testing of heat pumps and chillers (EN 14511, EN 14825) • Certification of PV modules (IEC EN 61215, IEC EN 61730) • Testing and performance evaluation of solar façade systems	efficiency, noise, energy consumption), • EU Ecodesign rules for solid-fuel boilers and stoves, emissions and efficiency requirements. • EU Energy Efficiency Directive (EED 2023), influencing system optimisation, energy assessments, and documentation. • EU Ecodesign ventilation requirements, EED for energy audits and performance improvements.
Construction	• CE marking and technical certification of construction products (performance and compliance) • Testing and verification of insulation materials, cement, concrete additives, clay, mortar, brick, and sand/aggregates • Accredited testing of windows, doors, and façades • Assessment of construction cables for fire performance • Certification of glued load-bearing wooden structures and factory-built wooden houses • Examination and certification of temporary structures (e.g. scaffolding) • HQE (High Environmental Quality) building certification • Environmental assessments (LCA, EPD) verification for construction products • Heat pump certification (Heat Pump KEYMARK)	National: • Spanish Technical Building Code (Royal Decree 314/2006) • Swedish Planning and Building Act • Swedish Work Environment Authority regulations • German regional building regulations (Building Products Act) EU: • Construction Products Regulation (CPR) – (EU) No 305/2011 (and its amendments) • CE Marking of Construction Products • ETA – European Technical Assessment • Keymark and other voluntary European certification schemes for building-related products • Sustainability, LCA and EPD (Environmental Product Declarations) for construction products • Energy Performance of Buildings Directive (EPBD) – 2010/31/EU and recast 2018/844/EU (and amendments)

		• Ecodesign and Energy Labelling Regulations for certain building-related technical systems (heating, cooling, ventilation equipment) • REACH Regulation – Regulation (EC) No 1907/2006 • Emission testing of VOC and formaldehyde from building products • CLP Regulation – Regulation (EC) No 1272/2008 (input data for classification and labelling of mixtures/materials, e.g. content of hazardous substances, emission characteristics) • EU Ecolabel and national/voluntary labels • Life Cycle Assessment (LCA) of construction products and buildings • EPD (Environmental Product Declarations) for construction products according to EN 15804 • General Product Safety Regulation (GPSR) • Machinery Regulation / Directive
Mobility	• Pre-qualification testing of electrical vehicle charging systems • Accredited automotive electronic component testing (CE and E-marking) • Type-approval support for automotive parts and equipment • Technical evaluation for Individual Vehicle Approval (IVA) • Accredited road surface and infrastructure measurement/testing • Safety assessments of automated driving systems (incl. ISO 26262, SOTIF) • Testing of electric vehicle charging systems for interoperability and compliance	EU: • Electric Vehicle Charging Regulation • Electromagnetic Compatibility (EMC) Directive 2014/30/EU • EU Automotive Directive • EU Regulations 2018/858, 167/2013, and 168/2013 (vehicle type-approval)
Electronics	• Accredited Electromagnetic Compatibility (EMC) testing services	• Electromagnetic Compatibility (EMC) Directive 2014/30/EU

	• Electrical safety testing of electrical/electronic products • Vibration and shock testing of electrical/electronic equipment • EMC pre-compliance measurements for CE marking • Accredited power electronics testing and validation • Certification of electrotechnical products (PN-EN ISO/IEC 17065) • Product development support including certification and pre-compliance testing	• Low Voltage Directive (LVD) 2014/35/EU • Radio Equipment Directive 2014/53/EU • Machinery Directive 2006/42/EC • Medical Device Regulation (MDR) 2017/745 (where electronics serve medical applications)
Medical devices	• Assessment of biocompatibility of medical devices (ISO 10993) • Medical device product testing and approval management (incl. CE marking) • Testing and certification of hearing devices (electroacoustic, EMC, wireless, safety) • Medical device quality management system certification (ISO 13485)	EU: • Medical Device Regulation (MDR) 2017/745 • In Vitro Diagnostic Regulation (IVDR) 2017/746 • Commission Implementing Decision (EU) 2021/1182 (harmonised standards for MDR)

Source: Technopolis Group (2025)

Moreover, some organisations (e.g. Tecnalia, Force Technology) act as notified bodies for competent authorities. For example, Tecnalia (Spain) is a notified body for the EMC Directive. Also, RISE (Sweden) is a notified body and technical assessment body under CPR, plus has certification body roles under MDR/IVDR.

The bullet points below include the main challenges encountered by TIs providing certification and standardisation services:

- The skills and competence needed for performing materials testing are different from the skills employed in R&D&I relating to new materials. This creates an obstacle for the flow of knowledge about new solutions (from R&D to market) and requirements (from market needs to R&D) that slows the innovation time.

- Continuous evolution of European and international regulatory frameworks, particularly in sectors such as construction, safety, and materials. Key aspects include: the revision of the Construction Products Regulation (CPR) and the introduction of new sustainability requirements; increasing alignment between CE marking, environmental performance, and circular economy metrics; growing demand for digital product passports and traceability and harmonisation challenges between European regulations and international standards. Testing laboratories and Technical Assessment Bodies (TABs) must therefore continuously update methodologies, accreditation scopes, and internal procedures.

- Maintaining compliance with multiple international accreditations and approvals while keeping testing capabilities up to date with rapidly evolving energy technologies (e.g. smart grids, high-voltage equipment, EMC requirements and digital metering systems) represents a major operational challenge. In addition, the high cost of specialised Technology Infrastructure and the need to navigate diverse international regulatory frameworks can create obstacles to efficient certification and global recognition of test results.

- For health, ensuring continuous compliance with regulatory and quality frameworks (ISO 17025, ISO 15189, GMP and national health authorisations) while keeping pace with rapid advances in genomic technologies and personalised medicine represents a major challenge. Additionally, maintaining highly specialised expertise, traceability, and data protection standards in genetic and pharmaceutical testing environments requires significant operational and infrastructure investments. An additional obstacle is the high regulatory and operational burden associated with maintaining multiple accreditations and GMP certifications, which requires continuous audits, strict documentation, and specialised personnel. In addition, the high costs of advanced laboratory infrastructure, data protection requirements for genetic information, and complex approval processes for clinical and pharmaceutical applications can slow down the deployment of new diagnostic or therapeutic solutions.

Ecosystem support services are also provided by AdMa RI&TIs. Most frequently, these come in the form of support to internationalisation (36%), as well as product / technology strategy development (30%) and community building (29%). Overall, 56% of RI&TIs provide at least one form of ecosystem support service, as shown in the Figure 23.

Finally, technological change and changing user needs demand constant upskilling to ensure that RI&TIs can attract talent and address the needs of their users[42]. Consequently, one of the objectives of the recent European RTI Strategy is to attract and cultivate talent in Europe through strong career pathways in RIs and TIs, from technicians to scientific leaders, developing new skills and competences[43].

In this context, **the findings indicate that most RIs and TIs provide skills and training services, with a strong emphasis on academic pathways and high-level talent development**. Examples of addressed skills include designing future materials (e.g. multi-functional materials), safe and Sustainable by Design (SSbD), including life-cycle assessment (LCA) & regulatory compliance. Over half of survey respondents offer master, PhD, postdoctoral, and fellowship programmes, making this the most common training modality. Specialised technology trainings are provided in-house and for external users by around two-fifths of infrastructures, while nearly one-third support secondment and mobility schemes, indicating a significant role in workforce upskilling and knowledge transfer.

In the context of Advanced Materials, several **skills and capability gaps** related to digital capabilities were highlighted by RI&TIs. As R&D processes in AdMa become increasingly digitalised, there is a growing demand for profiles that combine materials science expertise with skills in, for instance, data analytics, AI, software integration, and high-performance computing.[44] In addition, there is a lack of multidisciplinary capabilities (for instance, combining materials science, engineering, and chemistry) within single infrastructures, which hampers holistic innovation. In some cases, even when specialised instruments are available, the availability of trained staff who can operate equipment and prepare samples is insufficient.

Overall, while **the data highlights that RI&TIs also function as hubs for developing highly skilled human capital**, consultations with RI&TIs indicate that several challenges remain. Namely, **RI&TIs face difficulties in attracting and retaining talent**. RI&TIs operate in ecosystems where competition for talent with industrial/academic stakeholders further aggravates the skill shortage. To address the issue, infrastructures and their hosts have dedicated additional measures to retain and upskill the staff. To address the lack of skills within the ecosystem, collaborations with universities and joint skill development programmes are common[45]. For example, INESC MN collaborates with Técnico, the Engineering School of the

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[42] Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52025DC0497R(01)
[43] v Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52025DC0497R(01)
[44] Feedback from the European Commission's call for evidence on the future Advanced Materials Act (online link).
[45] Retrieved from https://ritifi.eu/deliverables/

University of Lisbon and other Universities in Portugal and Europe to train master's degree-level and doctoral-level students[46].

2.3. Potential AdMa RI&TI user landscape

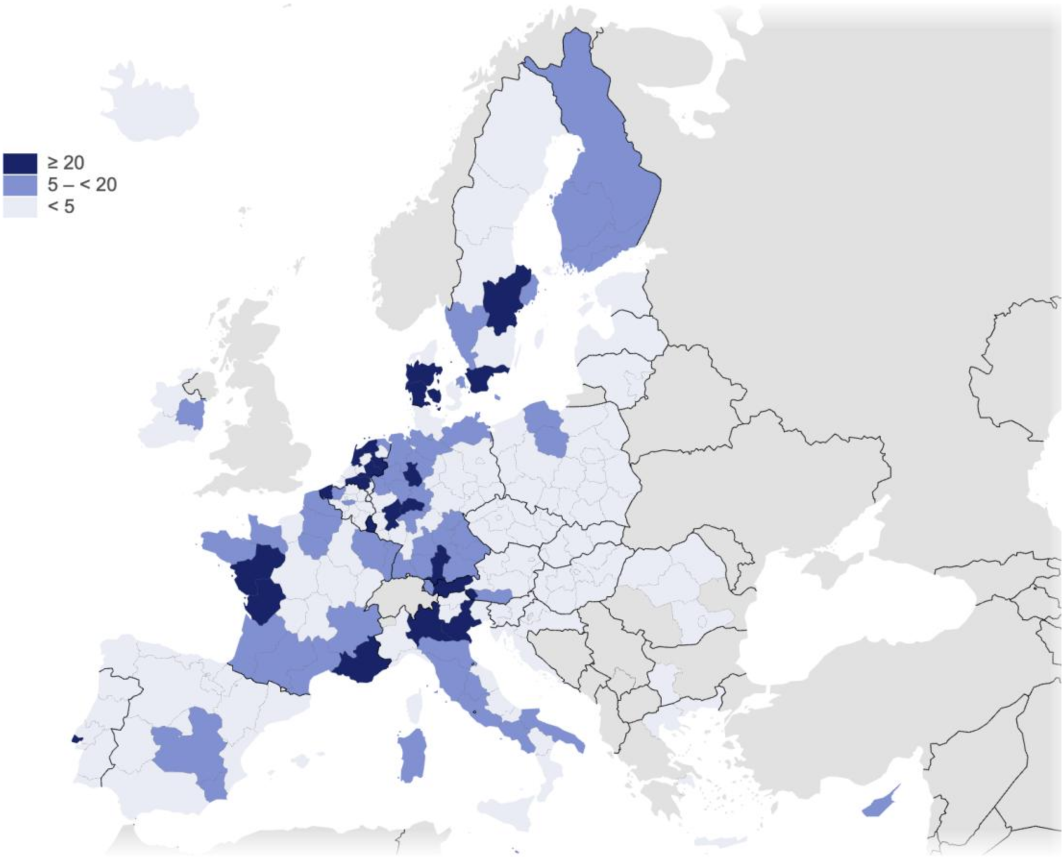
Regarding the distribution of potential AdMa RI&TI users[47], the analysis indicates that **potential AdMa RI&TI users are predominantly concentrated in Europe's strong and moderate innovator economies, mirroring the geographic pattern of AdMa RI&TIs themselves**. Germany (27%), France (14%), Italy (13%), and the Netherlands (9%) together account for nearly two-thirds of all potential AdMa RI&TI users. These countries possess well-developed industrial and R&D ecosystems, particularly in AdMa, automotive, aerospace, and chemical industries. Sweden (6%), Spain (5%) and Austria (4%) have moderate shares.

The figure below provides an overview of the co-location ratio of AdMa RI&TIs and their potential users at the regional level.

[46] Retrieved from: https://ritifi.eu/deliverables/

[47] We define potential AdMa RI&TI users as organization's that either file patent applications in the field of Advanced Materials or operate as innovative companies, start-ups, or spin-offs developing novel Advanced Materials or related products and technologies. Because these organisations are actively engaged in R&D activities, they are likely to benefit from the services offered by AdMa RI&TIs. This definition also enables us to distinguish between organisations that simply purchase Advanced Materials and those that are directly involved in advanced-materials research and development.

Figure 8 Overview of the potential AdMa RI&TI user and RI&TI ratio (co-location pattern) at regional NUTS2 level (values in the legend indicate number of users per one AdMa RI&TI).



Source: Technopolis Group. Results based on web-crawling analysis prepared by GlassAI and PATSTAT and Orbis IP analysis prepared by Technopolis Group. The distribution is based on 13,031 potential AdMa RI&TIs users and 2,943 AdMa RI&TIs.

In the most industrialised and innovation-strong regions of Europe, there is a balance between the number of AdMa companies and the AdMa RI&TIs. This alignment is particularly visible in Germany, France, Austria, Italy, the Netherlands, and the Nordic countries. Regions such as Oberbayern, Stuttgart, Karlsruhe, Darmstadt, Köln, and Dresden in Germany, Île-de-France, Rhône-Alpes, and Provence-Alpes-Côte d'Azur in France, and Wien, Niederösterreich, and Steiermark in Austria display relatively moderate company-to-infrastructure ratios, indicating that industrial demand and research capacity are well matched. The same applies to Lombardy, Veneto, and Emilia-Romagna in Italy, Noord-Brabant, and Utrecht in the Netherlands, where robust industrial clusters coexist with advanced TIs, fostering innovation diffusion and collaboration.

In some regions, the number of companies per infrastructure is considerably higher, suggesting potential RI&TI capacity bottlenecks. This is visible in Belgium's West-Vlaanderen, where a large concentration of companies contrasts with a smaller number of AdMa RI&TIs. Similarly, Midtjylland in Denmark and Zuid-Holland in the Netherlands stand out with high company-to-centre ratios, reflecting vibrant industrial activity but comparatively limited local RI&TI capacity. In the Area Metropolitana de Lisboa in Portugal, the high number of companies per infrastructure may signal growing demand for research, testing, and innovation services that exceed the available institutional supply.

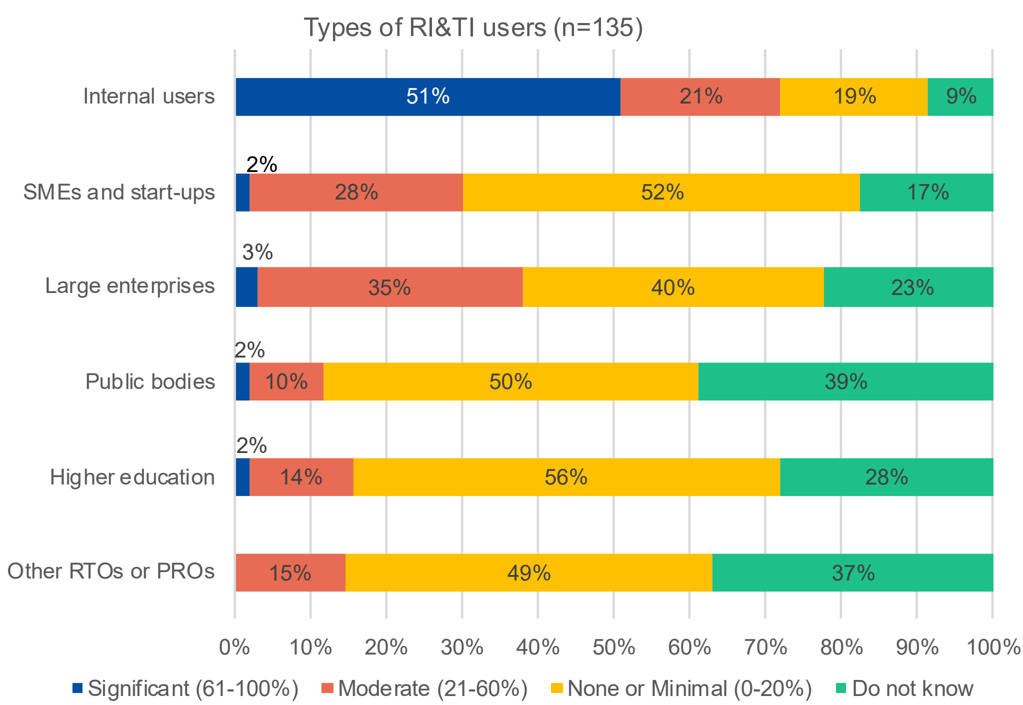
Nevertheless, the regional differences must be interpreted with caution. On the one hand, it is likely that companies established in one region can travel to access facilities located in neighbouring regions. On the other hand, there is a large presence of publicly funded research infrastructures compared to the industrial demand for their offered services. For example, in several Eastern European countries, the infrastructure base exceeds the local industrial base.

2.3.1. AdMa RI&TI user portfolio

The user portfolio of AdMa RI&TIs differs depending on the technological focus and offered services of the facilities. For example, RIs primarily target public users for individual projects or in collaboration with other research performing organisations. Industrial access to RIs occurs less systematically than for TIs, which cover a broad span of public and private end-users.

Regarding the composition of the user portfolio of surveyed AdMa RI&TIs, internal users (e.g. RI&TI staff and research staff from host organisations) make up the largest share of total users (see figure below). The share of internal users is similar for both RIs and TIs. This indicates that surveyed RI&TIs are not primarily focused on service provision to businesses. **Among external users, 35% of the RI&TIs reported that large companies constitute a moderate user base**, followed by SMEs (for 28% of RI&TIs focused on AdMa, SMEs are a moderate user base, ranging between 21 and 60% of all users).

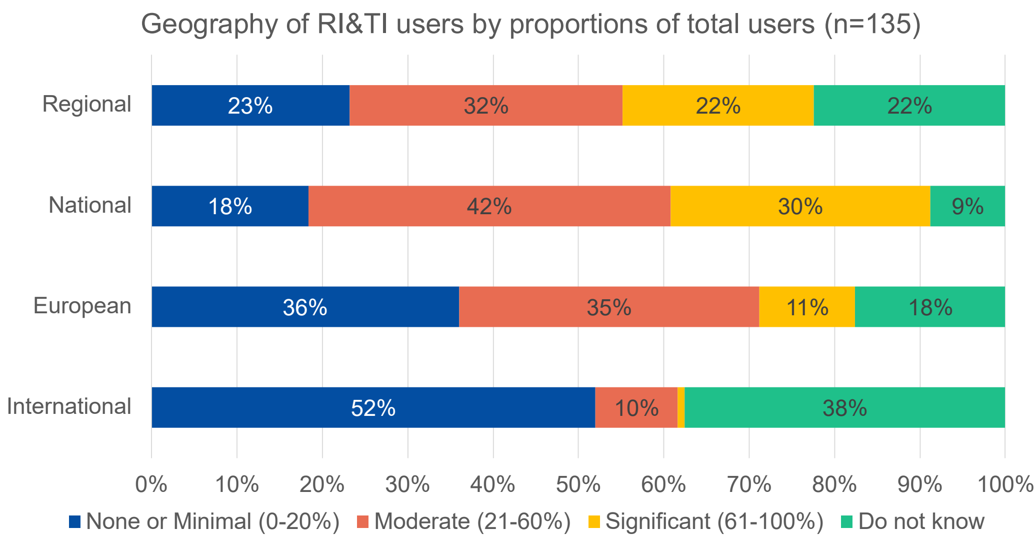
Figure 9 Types of RI&TI users by proportion of all users.



Source: Technopolis Group (2025) based on results from RI&TI AdMa mapping survey

When considering the geographical distribution of RI&TI users, most RI&TIs mainly work with regional and national users, with European users representing a secondary group and international users remaining minimal (see figure below).

Figure 10 Geography of RI&TI users by proportions of total users.



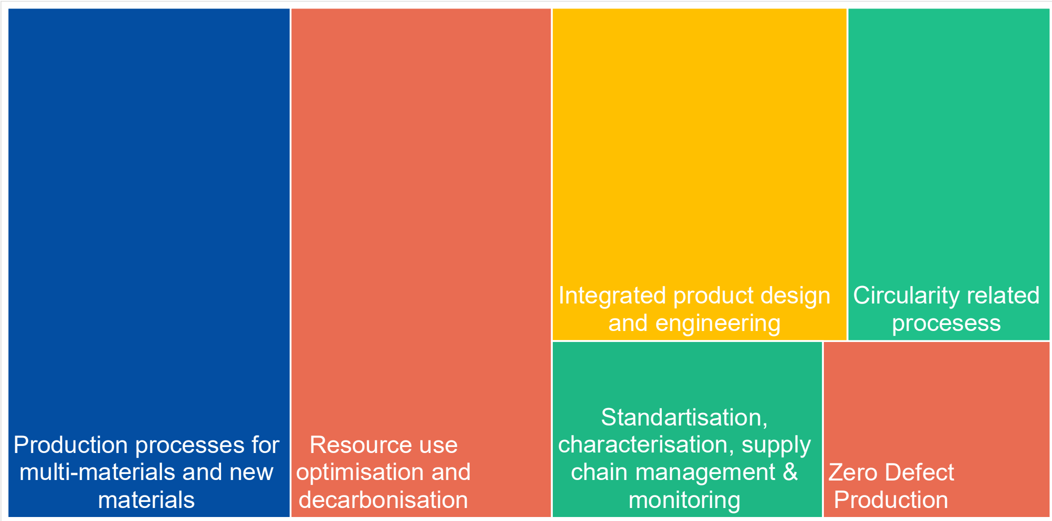
Source: Technopolis Group, based on AdMa RI&TI survey results.

More specifically, 84% of surveyed AdMa RI&TIs report none or a minimal share of international users. **European users account for a slightly higher proportion, with 35% of AdMa RI&TIs reporting that these users represent 21-60% of all users, suggesting some level of cross-border engagement within Europe, though still limited overall.** In terms of nation-wide users, for 30% of AdMa RI&TIs, they constitute a significant user base and for 42% a moderate user base (21-60%).

2.3.2. User needs addressed by AdMa RI&TIs

RI&TIs play a critical role in supporting innovation across all stages of the AdMa value chain. The facilities support a diverse range of industrial and research priorities across different thematic areas. An overview of the addressed user needs is presented in the figure below.

Figure 11 Overview of the addressed user needs.



Source: Technopolis Group (2025) based on results from RI&TI AdMa mapping survey. Note: The size of the rectangles represents the number of times a specific user need has been addressed.

More specifically, RI&TIs support users by:

- Providing access to new production technologies, including production and processing monitoring and control, multi-material joining and 3D/4D printing, as well as AI-based high-throughput screening methods.
- Ensuring resource use optimisation and decarbonisation, including the reduction of energy consumption, integration of renewable energy sources, CO2 capture and reuse, and the replacement of hazardous chemicals with safer alternatives.
- Addressing the need to incorporate Safe and Sustainable by Design (SSbD) principles, use sustainable chemicals, and improve product lifespan and life-cycle assessment.
- Developing new processes for circularity, with demand for cost-effective recycling, repair and re-manufacturing processes, waste valorisation processes with emphasis on complex materials mixture, and catalyst development.
- Zero-defect production, which focuses on new and more accurate and intelligent sensing systems to collect data on material production, running simulations in the laboratory and product tracking along the value chain.
- Facilitating mass customisation, centred on consumer integration and flexible, modular production processes, flexible supply chains and marketplaces. This calls for improved data management, standardisation, and regulatory testing, resilient use of trusted secondary materials, instrumentation and metrology for characterisation, monitoring and control, focusing on platforms that support materials marketplaces and collaborative end-of-life management.
- Providing services related to instrumentation and metrology for characterisation, monitoring and control, including offerings of platforms for extended AdMa marketplaces, collaborative products/components end-of-use forecast and management and materials testing and qualification.

To better understand their users' needs, several RI&TI operators report carrying out regular (e.g. yearly) road mapping exercises and forecasts of user needs, market

research to identify potential new directions. The road mapping is usually integrated into the overall strategy of the organisation, and the regularity of the exercise varies depending on the TI provider's strategic planning process (albeit often entailing yearly updates linked to the reporting process and distribution of basic funding to the institutes)[48]. Such needs assessments and exercises are also conducted through less formal means, for instance, through daily interactions with users. **Consequently, understanding evolving user needs is essential for maintaining state-of-the-art facilities**.

2.3.3. Evolution of AdMa RI&TI user needs

According to the interviewed stakeholders, **over the next five years, the needs of industrial users, especially SMEs, are expected to evolve significantly in response to the twin (green and digital) transition.** Companies will move beyond seeking compliance-based testing and demand integrated support for sustainable product design, life-cycle assessment, and circularity metrics. At the same time, companies will require infrastructure that combines advanced physical testing with digital simulations, enabling the development of reliable "digital twins" that cut prototyping costs and accelerate innovation.

In materials science and advanced manufacturing, user needs will increasingly revolve around functional coatings, additive manufacturing, bio-based polymers, recyclable composites, and energy-efficient processes. Companies will expect support for fast validation, particularly in areas such as building-integrated photovoltaics (BIPV), smart glass, and lightweight materials. Demand for validation under real-world conditions will grow, especially as industries look to accelerate commercialisation while ensuring durability, reliability, and regulatory compliance. SMEs, often resource-constrained, will rely heavily on shared infrastructure, pilot plants, and consultancy to access high-performance materials and innovative production methods without bearing prohibitive costs.

Across sectors, digitalisation will be a defining factor. Industrial users will expect AI-driven data analysis, advanced characterisation techniques, and correlative workflows that provide actionable insights rather than raw data. This will be complemented by scalable, flexible, and remote-access models, reflecting a broader move toward decentralisation of R&D. Companies will increasingly require RI&TIs that integrate digital and physical workflows, allowing simulations to directly inform experiments and vice versa. In fields like biotechnology and pharmaceuticals, SMEs and start-ups will demand tailored, rapid services such as modular imaging packages, integration with omics platforms, and regulatory-compliant data generation. In parallel, energy and defence industries will seek high-performance ceramics, polymers, and photonic components aligned with sustainability and dual-use technologies. To respond to these needs, RI&TIs will need to strengthen their computational capacity, invest in data-driven methodologies, and adopt common data standards to ensure interoperability.

The next five years will see industrial users seeking infrastructure that is not just a testing service but a strategic partner in innovation. Facilities will need to adapt by scaling up to demonstration levels, embracing interoperability and digital integration, and offering end-to-end support across the innovation pipeline. This comprehensive role will be particularly vital for SMEs, enabling them to compete in increasingly complex and fast-moving global markets.

Another demand that will become more pressing in the coming years relates to sustainability, circularity, and SSbD methodologies. **User needs related to sustainability will intensify as sectors face stricter environmental and regulatory requirements.** Companies will seek infrastructures capable of providing comprehensive environmental footprint assessments,

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[48] European Commission: Directorate-General for Research and Innovation, Policy landscape supporting Technology Infrastructures in Europe – Final report. Annex II, Case studies, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2777/88866

evaluating recycled feedstock quality, supporting chemical safety testing and embedding SSbD methodologies throughout the development process.

Demand is also expected to grow for **materials supporting strategically important sectors** such as microelectronics, energy storage, hydrogen technologies, unmanned systems, and advanced manufacturing. Users in these areas will require facilities offering specialised testing conditions, access to advanced characterisation equipment, and expertise in handling critical raw materials and substitution pathways. RI&TIs will need to reinforce strategic capacities, including high-precision testing platforms, advanced cleanroom environments, and expertise in reliability and integration challenges.

An additional need concerns **cross-infrastructure coordination and seamless user pathways**. As AdMa development becomes more complex, users will depend on smooth transitions between facilities offering complementary capabilities. Emerging needs include more structured referral mechanisms, shared service frameworks and integrated user journeys connecting modelling, prototyping, characterisation and scale-up.

In addition, the **demand for the combined RIs and TIs services offer may grow** in sectors of strategic importance for the EU. The path the technology development takes from its testing to demonstration to commercial uptake in bioeconomy would greatly benefit from the bundling of services, with smaller biotech firms to be the main winners of such a service offer, provided access to such services is affordable. Connected to this is the importance of the availability of robust RIs and TIs services offered in direct geographic proximity to industrial users. The evidence from the clean hydrogen sector shows there is a “proximity effect” among companies, e.g. companies using services of RIs and TIs that are close to them geographically or/and culturally. This calls for considering a sectoral approach to strategic development of RIs and TIs services drawing on industrial capabilities in a specific geography (e.g. regional, cross-regional, national, cross-national).

2.4. Gaps in the service offerings and sectoral coverage of AdMa RI&TIs in the EU

In the EU, there is a large landscape of RI&TIs which are generally well equipped in terms of thematic and sectoral coverage. However, to remain state-of-the-art, facilities have to be constantly updated and aligned with evolving user needs. Considering how user needs have evolved and will change in the future, and difficulties RI&TIs face in funding facility upgrades (see section 4.2), several gaps emerged in the AdMa RI&TI landscape. The gaps presented below were collected and prioritised by RI&TIs and their potential users.

Consulted stakeholders also highlighted that although they may face access gaps in their local or national networks, the necessary services or capabilities might exist elsewhere at the EU level. This means that, on the one hand, users and often RI&TIs are not aware of the existing capabilities across the EU. On the other hand, users face practical barriers to timely and affordable access to the facilities (see section 4.1).

Gaps in the service offerings of AdMa RI&TIs in the EU

Several gaps have been identified in the service offerings of AdMa RI&TIs that limit their ability to support materials innovation from early research to scale-up and deployment of AdMas.

Limited availability of pilot-scale and pre-commercial production facilities. Industrial users, particularly SMEs, often require multi kilogram batch production, materials compounding, or higher-TRL testing that exceeds the typical scope of laboratory-scale RI services. At the same time, some infrastructures face constraints in resources or physical space that prevent capacity expansion despite clear user demand.

Another important gap relates to **digital, AI, and computational capabilities**. Modern AdMa R&D is increasingly driven by AI-supported design, HPC-enabled simulation, and automated laboratory workflows. Yet, **the availability and access to modelling, simulation, and computational tools across infrastructures remain uneven**. While some facilities offer advanced digital metallurgy or AI-assisted material development, these capabilities are not widespread. There is a growing need for infrastructures that integrate digital and physical testing environments, such as combining AI with additive manufacturing, robotics, or automated characterisation. However, the automation of TI processes remains challenging and time-consuming[49], and many workflows are still largely manual. Gaps are also noted in data management, including inconsistent definitions, limited interoperability, and insufficient tools to link material development with validation processes, especially in circularity-related applications.

In regulated and application-driven sectors, **conformity testing and certification services** are insufficient or unevenly distributed. Examples include cryogenic hydrogen tank testing, materials qualification for medical applications, construction products, and other safety-critical domains. Limited domestic availability of such services increases costs and time-to-market, particularly for SMEs.

Gaps also persist in support for **recycled materials, integrated recycling processes, and environmental impact assessment**. To respond to regulatory and market pressures to demonstrate sustainability performance, AdMa RI&TIs need stronger and more systematic capabilities aligned with environmental and safety frameworks. In particular, the integration of SSbD principles remains uneven, with relevant services still under development and not yet consistently available across infrastructures.

System-level service gaps have also been identified in value-chain integration. RI&TIs are often not sufficiently connected to industrial demand, start-up ecosystems or downstream application developers. Missing elements include co-location environments for industry researchers, coordinated support for spinouts beyond early R&D, and mechanisms ensuring that RI&TI investments translate into deployable products and applications.

Gaps in the sectoral coverage of AdMa RI&TIs in the EU

In the **energy** sector, there is a gap in the services for testing materials under realistic or extreme operating conditions. This includes limited availability of facilities capable of conducting high-temperature or harsh environment experiments, which are essential for validating materials used in energy production, storage and conversion. There is also an insufficient capacity for studying in operando material behaviour, an increasingly important requirement for catalysis, electrochemistry and energy-related functional materials. In addition, the sector requires more advanced modelling and simulation tools to predict material performance throughout its lifecycle, yet such capabilities remain uneven across infrastructures.

In the **mobility** sector, gaps exist in infrastructures supporting lightweight materials, thermal management solutions, and advanced composites. RI&TIs often lack the modelling capabilities and experimental facilities needed to optimise thermal behaviour in mobility applications, including materials for electric vehicles and aerospace components. There is also a shortage of mid-scale facilities able to produce composite or polymer formulations at relevant batch sizes, which hinders validation for automotive, aerospace and rail applications. Recycling capacities relevant to mobility materials, such as polymer or composite recovery, also remain limited, affecting circularity objectives in the sector.

In **electronics**, significant gaps remain in materials development and testing capabilities for microelectronics and semiconductor components. Europe lacks sufficient RI&TIs dedicated to AdMa used in integrated circuits, microchips, and high-performance electronic devices. Experts pointed to a shortage of specialised testing platforms, cleanroom-adjacent infrastructures and integration environments capable of supporting reliability assessment, material compatibility

[49] IAM4EU, Strategic Research and Innovation Agenda (2024). https://www.iam-i.eu/wp-content/uploads/2025/02/SRIA-Innovative-Advanced-Materials-for-Europe.pdf

testing, and high-precision characterisation. Human expertise and R&I capacity in this domain were also considered insufficient to meet rising demand in strategic technologies, including components for advanced communication systems and autonomous platforms. Additionally, while key industrial sectors will increasingly depend on high-field superconductors, the EU currently lacks the scale and diversity of testing infrastructure needed to qualify materials, validate prototypes, and carry out system-level demonstrations[50].

Sector-specific gaps in the **construction** sector relate primarily to formulation work, polymer and composite development, and the validation of new materials for durability and safety. SMEs in the construction sector often require multikilogram test batches of materials such as coatings, binders or polymer mixtures to perform structural or performance testing; however, infrastructures offering such intermediate scale production remain scarce. Facilities able to support environmental performance assessments, including long-term degradation or exposure testing, are also limited. This constrains the sector's ability to adopt innovative materials that meet both regulatory and sustainability requirements.

In the medical sector, gaps were highlighted in terms of infrastructures providing specialised testing services related to **biocompatibility**, environmental and health safety, and regulatory compliance. Companies often require material performance data aligned with stringent medical standards, yet the availability of RI&TIs offering such services is inconsistent. Capacities to evaluate environmental imprint, chemical safety or material interactions in biological settings remain uneven across Europe.

3. AdMa RI&TI mappings and inventories

RI&TI mappings (or inventories) are structured databases or catalogues of major research or technology facilities, equipment, and services. They can exist at different levels: European or national platforms that aggregate many infrastructures, and operator-level inventories maintained by individual research organisations or labs. At the EU or national level, mappings often serve a strategic overview function – identifying the landscape of infrastructures across regions or sectors. At the operator level, a mapping is essentially an asset register or service catalogue that an RTO, university, or facility uses to showcase its capabilities. In both cases, the goal is to make infrastructures visible and accessible to potential users and decision-makers. The purpose/objectives of such mappings/inventories are summarised below:

- **Facilitating scientific collaboration**: By knowing what exists where, researchers can form collaborations or request access to instruments they do not have in-house.
- **Enabling industrial services and innovation**: A core goal of Technology Infrastructure mappings is to connect industry (especially small companies) with development and testing facilities.
- **Policy planning and funding decisions**: Governments use mappings to inform strategy. If, for instance, a country sees in its inventory that it has no test facility for hydrogen technologies, that gap can be addressed in the next funding programme.
- **Capturing usage and impact data**: some mappings are linked to monitoring. By keeping an inventory and possibly collecting data on each infrastructure (like number of users, projects, etc.), funders can assess the impact.

One of the primary roles of mappings is to **attract users** by raising awareness of available facilities. A comprehensive inventory makes it easier for an SME, for instance, to find a testing facility or pilot line, which in turn drives utilisation and revenue for the infrastructure. For example, Japan's ARIM initiative (Advanced Research Infrastructure for Materials and

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[50] Feedback from the European Commission's call for evidence on the future Advanced Materials Act.

Nanotechnology) explicitly provides a platform through which a company with an idea can locate and use cutting-edge facilities to prototype and test products[51]. Overall, they lower barriers for companies to engage with infrastructures.

In terms of **funding,** policymakers use mappings to identify which infrastructures are of strategic importance or in need of upgrades. Being listed signals that a facility is part of the national R&I ecosystem, potentially making it eligible for funding programmes. Some mappings are tied to funding roadmaps. Thus, inclusion in an official mapping can directly influence funding opportunities (for maintenance, upgrades, or new projects), creating an incentive for operators to participate**. Mappings also capture operator needs** by surveying facilities, authorities learn about gaps (e.g. missing capabilities, outdated equipment) and can tailor funding calls to address them).

In terms of specific mappings/inventories of AdMa RI&TIs, the most common are organisational-level mappings, e.g. catalogues maintained by single institutions or networks for their own facilities. Most entries in the EU mapping inventory dataset correspond to organisation-specific portals or databases. **Nearly every major RTO or technical university has an online listing of its labs, equipment, or technology platforms**.

National and regional mappings are fewer in number but often broader in scope. National mappings are typically sponsored by governments or national agencies to list all significant infrastructures in the country (sometimes as part of a research infrastructure Roadmap). Not every Member State has a formal national RI&TI inventory. For example, Spain maintains the ICTS (Unique Scientific and Technical Infrastructures) map for large RIs, the Materplat capacity map[52] and it has also launched specialised maps like AM@ESP for AdMa (spanning multiple regions).[53]

At the EU level, there have been a few mapping initiatives, typically funded by the European Commission. Examples include the CatRIs project which built on lessons learned from the MERIL which catalogued research infrastructures across Europe, the European Network for Pilot Production Facilities (EPPN)[54] and more targeted efforts like the RINGO mapping which was limited to aerospace sector. In addition, the websites of the Open Innovation Test beds list members' RI&TI established across EU that have a focus on AdMa.[55]

3.1. Filtering and scope

In practice, many mappings do not differentiate and list research facilities broadly, ranging from basic science labs to applied technology test beds. For instance, the Spanish AM@ESP platform includes universities and research as well as companies and collaborative projects on a single map without labelling them separately. This lack of differentiation was noted as a common trait in mappings; many inventories use generic categories like laboratory or facility without classifying if it is primarily a research-oriented infrastructure or a demonstration/validation-oriented one.

Some mappings are implicitly focused on one or the other type of infrastructure. RI maps tend to list entities like national laboratories, observatories, large scientific installations, etc., which align with the traditional RI concept. TI maps list pilot lines, test beds, innovation hubs, and other facilities aimed at product development and upscaling. For example, the EU's clean and

[51] Retrieved from: https://www.nature.com/articles/d42473-022-00115-z
[52] Retrieved from: https://materplat.org/herramientas/capacidades/
[53] Retrieved from: https://www.nanociencia.imdea.org/home-en/news/item/am-esp-the-new-research-and-industry-platform-of-the-complementary-programme-in-advanced-materials
[54] Retrieved from: https://www.eppnetwork.com
[55] For example, the website of OITB LEE BED list available pilot lines. Retrieved from: https://www.lee-bed.eu/services

renewable energy TI mapping identified technology centres providing advanced services for industry[56].

Most mapping platforms provide search or filtering tools to help users find relevant infrastructures. The extent and sophistication of these filters, however, vary widely. The table below provides an overview of four mappings.

Table 2 Overview of AdMa RI&TIs mappings/inventories

Mapping Platform	Level & scope	Infrastructure types	Available filters/search	Maintaining authority
AM@ESP (Advanced Materials Spain)	National/regional (Spain, 7 regions); focused on AdMa R&D and innovation facilities (centres, research groups, projects, and interested companies).	Both RIs & TIs in AdMa (labs, centres, pilot projects; not distinguished by type).	**Interactive map** (shows regions); Filter by region (highlight on map), by entity type (university, research centre, company), and by strategic research line (sub-field of AdMa). Searchable database of hundreds of groups.	Spanish Ministry of Science + Regional governments (Complementary Programme on AdMa). Updated via programme input; launched 2023.
MERIL (Mapping of European RI Landscape) *[defunct]*	EU-level (pan-European); broad scope across all research fields.	Predominantly RIs (scientific research infrastructures: databases, observatories, laboratories, etc.).	Filter by **scientific domain** (e.g. life sciences, materials science), by country, and by type of infrastructure. Search by keyword. (No separation of TIs, as focus was on RIs; tech-oriented facilities were underrepresented.)	European Science Foundation (EU project, 2010s). Last updated ~2018. Funding ended – superseded by other initiatives (sustainability issue).

[56] Mapping of Technology Infrastructures supporting clean and renewable energy industries in Europe, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2777/028028

Mapping Platform	Level & scope	Infrastructure types	Available filters/search	Maintaining authority
MATERPLAT (Capacity Mapping of Spanish Research)	Spanish Materials Research Facilities	It covers materials related research laboratories and industrial facilities	Predominantly covers general data, contact data, type of materials and type of materials related facilities	It is maintained by the Spanish Materials Platform, MATERPLAT , financed every year by the Spanish Ministry
EPPN **Pilot Production** **Facilities**	EU Level	The website contains 175 Materials Pilot Production Plants from 19 countries	It is possible to find pilot production plants of materials by country, by member	The creation of the Network was financed by the European Commission. INL coordinated the initiative. Project finalised in 2020

Source: Consortium.

From the analysis, about one-third of mappings offer robust multi-criteria filtering (e.g. combining field + location + type), another large portion have basic filtering (by field or region only), and some very simple listings have none beyond a text search box. The more advanced platforms – often those designed with industry users in mind – clearly stand out. AM@ESP is noted as user-friendly with its interactive map and multiple filters, which is likely to increase its utility for stakeholders. Meanwhile, older or one-off mappings presented as PDF reports (without an online database interface) lack interactive filters, reducing their accessibility.

The overview of collected inventories suggests that only a minority of mappings have a dedicated category or filter for AdMa. Approximately 20–30% of mappings explicitly include "Materials" or "Nanotechnology" as a field in their taxonomy. For those that do, identifying AdMa infrastructures is straightforward. For instance, the MERIL portal (when it was active) had "Physical Sciences > Materials Science" as a domain, which would list materials research labs. Likewise, many national RI lists include Materials Science as a discipline.

However, the majority of mappings do not label infrastructures by such fine-grained fields. In these cases, identifying AdMa-related facilities relies on keyword searches or manual filtering. A user might have to search for terms like "materials", "nano", "chemistry" within the database. Some national databases were reported to allow free-text search only, meaning a query for "materials" might pull up any facility with that word in its name or description (with varying success).

3.2. Maintenance and upgrade

In many cases, government bodies, agencies or RI&TI providers are in charge of maintaining and upgrading the mapping. More specifically:

- A significant number of national mappings are overseen by a science ministry, innovation agency, or research council. For example, the Polish research infrastructure map is managed by the Ministry of Education and Science; the French “Roadmap of Research Infrastructures” portal is under the Ministry/Higher Education research apparatus; and Spain’s ICTS is run by the Ministry of Science, and the Spanish Materplat (Materials Platform) mapping of materials stakeholders activities is financed on a yearly basis by the Spanish Ministry.
- Many large multi-site RTOs have internal maps made public. For example, Fraunhofer-Germany has an online directory of its centres and labs, and **CEA-France** lists its technology platforms. These are maintained by the organisation’s own staff. They serve the dual role of internal inventory and external marketing.

In terms of maintenance of the mappings/inventories:

- **Some are updated through periodic calls.** For example, a ministry may issue a call every few years for institutions to update or propose new entries.
- **Other mappings are based on one-time data collection (e.g. created by a project).** For instance, MERIL gathered data in the mid-2010s; once the project ended, the data became outdated, and the portal is now offline. EPPN was updated until the project finished (2020), but the website remains active.

Overall, the frequency of updates ranges from annual (some active national databases) to multi-year (every 3-5 years aligned with funding cycles) to one-off. **Generally, EU-level mappings have struggled with sustained updates, often tied to a specific project or study.** National mappings linked to government research infrastructure strategies tend to have better longevity. Maintenance of organisational mappings is dependent on resources; a company or region might update its list when new facilities open or projects start, but this can be irregular.

A noted sustainability issue is that maintaining a comprehensive mapping is resource-intensive (requiring staff for data curation, IT for the platform, outreach to infrastructure operators, etc.). In contrast, when a mapping is embedded in an existing structure (like a ministry or an agency’s mandate), it stands a better chance of being maintained long-term. For example, Japan’s ARIM platform is government-funded for the 2021-2025 period, with dedicated support for user portal operation and data management.

3.3. Lessons learned

Drawing from the analysis of existing mappings, several key lessons emerge on how to effectively develop and sustain RI&TI mappings and inventories:

- **Ensuring long-term sustainability, particularly at the EU level**: there is a need for a long-term strategy to maintain and update mappings. Interviewees have recommended embedding mappings in established structures or programmes. For instance, integrating the maintenance of a mapping into a European Partnership or a permanent agency that can secure continuous resources. Similarly, national maps tied to recurring budget cycles fare better than ad hoc ones.
- **Plan the “afterlife” of any mapping from the start**: it is important to identify who will own it, how often it will be updated, and how it will be financed and to align mapping updates with major policy milestones.
- **Robust governance and stakeholder engagement**: governance refers to both the management of the mapping and the involvement of key stakeholders (infrastructure operators, users, funders) in its development. Good practices show that a multi-stakeholder governance model leads to a richer and more widely accepted inventories.

- **Leverage existing mappings**: A recurrent lesson is to build on what is already there. Many countries or sectors have developed some form of inventory; starting a new mapping without referencing these risks duplication and stakeholder fatigue. Instead, successful projects often aggregate and harmonise existing databases.
- **Define clear scope and establish review processes**: A mapping must have a clearly defined scope in terms of what qualifies as an infrastructure, what information to collect, and quality thresholds to be effective. Lack of clarity leads to inconsistent entries.

4. Towards an accessible and sustainable RI&TI landscape for the uptake of Advanced Materials

4.1. Users & access modalities – trends, challenges and gaps

4.1.1. User journey and access conditions

Access to AdMa RI&TIs is crucial to reduce the high capital investment that users, particularly SMEs and large companies, are required to make, from research and technology development to commercial deployment. The main reasons companies, particularly SMEs, access such RI&TIs are to reduce the cost, length and risk of innovation; and have access to know-how, test and validation facilities.

Each journey is structured into four stages: 1) awareness, 2) consideration / negotiation, 3) use of service, and 4) towards strategic partnerships.

Awareness: The journey usually starts when users identify a technical or innovation need that cannot be addressed internally. Users then search for suitable infrastructures through professional networks, conferences, online resources, industry associations, or previous experience. Finding information on TI offerings through internal networks plays a crucial role, especially in smaller regional ecosystems. Despite these channels, consulted stakeholders indicated that limited awareness of available TIs remains a common challenge, both at a national and transnational level.

Consideration/negotiation: Once a suitable TI is identified, users initiate contact to discuss their needs and clarify objectives, technical feasibility, and expected outcomes. Access is typically formalised through an access agreement, which provides legal and operational clarity, helps establish trust (especially when commercially sensitive data are involved) and prevents misunderstandings about access conditions or the use of generated results.

Access frameworks are terms and conditions that define infrastructure access modes, offered services, training requirements, IP rights, data protection, confidentiality, liability, and fee structures. Addressing issues such as IP ownership, confidentiality, and liability is fundamental to mitigating risks and maintaining long-term collaboration. Managing these aspects effectively helps prevent misunderstandings regarding the scope of access, data handling, or the use of results generated through the infrastructure.

In terms of the content of the access condition / framework agreements, according to our survey results, most RI&TIs include specific clauses on the purpose and scope of user access (59%) and confidentiality (59%) in their access agreements. These are the most frequently addressed aspects, reflecting their importance for clarifying service boundaries and protecting proprietary or sensitive information. IP provisions are also common, included by 48% of respondents, highlighting the need to clearly define ownership and usage rights for research outputs. Around one-third of RI&TIs (37%) include clauses on data management and liability, while only a small share (5%) reported additional specific requirements (see Figure 24).

Insights from the interviewed AdMa RI&TI providers confirm that confidentiality and responsible data handling are central to most access frameworks. Some infrastructures require non-disclosure agreements (NDAs) to be signed before external users gain access to facilities or data, ensuring the protection of both industrial and research interests.

Use of services: During the service delivery phase, TIs' staff typically operate the equipment on behalf of users. The RI&TI staff operate the equipment on behalf of users, underscoring the central role of in-house expertise in enabling access. Typically, users work alongside RI&TI operators' teams during facility use, suggesting that collaborative, staff-assisted access remains one of the most common approaches. This trend also reflects that operating facilities require state-of-the art knowledge and skillset which many companies do not possess and rely on the critical capacities of RI&TIs. While many stakeholders indicated that remote/virtual access to services and facilities would significantly help adjust geographical distance barriers, only a few AdMa RI&TIs offer remote or virtual access.

This also reflects the fact that companies, particularly SMEs, seek not only access to advanced facilities but also to the specialised expertise required to use them effectively. Operating complex equipment often requires state-of-the-art knowledge that many companies do not possess internally. Independent access is therefore limited and usually conditional on mandatory training.

Towards strategic partnerships (user retention) – continuation of collaboration: Following initial service use, many TIs have processes in place to retain users and encourage continued collaboration. This may include follow-up support, involvement in collaborative projects, or the development of longer-term strategic partnerships, enabling repeated access and deeper integration of RI&TI capabilities into industrial innovation activities.

Nevertheless, several types of access restrictions apply to AdMa RI&TIs. The most common limitations are related to infrastructure scheduling constraints, cited by 75% of surveyed infrastructure providers, **and site-specific safety, environmental or training requirements**, cited by 74%. Infrastructures with complex or high-risk equipment frequently impose strict safety and training obligations before granting access to external users, particularly where accreditation or certification requirements must be maintained.

Other forms of access restriction include security checks or background screening procedures (applied by 48% of RI&TIs), proof of insurance coverage (applied by 41% of RI&TIs). The security checks and background screening are closely related to specific user category restrictions (reported by 12% of RI&TIs) and national or country-of-establishment restrictions by 22%. According to the interviewed RI&TIs, such measures are typically linked to legal or geopolitical considerations rather than institutional preference. **Several providers reported that national laws and institutional policies restrict access to RI&TIs, as in the case of Polish infrastructures that apply national security regulations**. In such cases, access restrictions were updated following geopolitical developments, such as the implementation of bans on users from Russia and China after 2022 or the exclusion of nationals from countries designated as high-risk.

Overall, **access restrictions to RI&TIs are primarily shaped by operational, legal, and safety-related factors, with few infrastructures imposing barriers based on user type or nationality**. This indicates a broad commitment to openness and collaboration within the limits of safety standards and national security obligations.

4.1.2. Access challenges

Industrial users, particularly SMEs and start-ups, face barriers when accessing AdMa RI&TIs. These barriers include a lack of understanding of the practicalities of accessing TIs, such as funding requirements, technical knowledge, IPR considerations or even a lack of information and a misunderstanding of the services provided by TIs.

Financial constraints.

The financing arrangements associated with access to RI&TI depend on the type of services offered and the types of users who access the infrastructure. The data on fee ranges among RI&TIs show a broad variation in access costs, suggesting that RI&TIs operate under a wide spectrum of fee structures. Based on the AdMa RI&TI survey, users' fees most often range between €5k–€20k, or are below €5k. In several cases, the most often fees paid by users reach higher ranges up to €150k–€500k. Rarely, users pay above €500k for the provided services.

According to the consulted AdMa RI&TI users and operators, in most cases, cost arrangements at RI&TIs are determined on a case-by-case basis. More than half of the respondents (58%) reported that access fees are negotiated individually, reflecting a flexible approach that can accommodate different project types and user needs. In such cases, RI&TIs apply differentiated tariffs, where, for instance, academic users pay subsidised internal rates, while companies are charged market-competitive commercial rates to avoid distortion of competition. Although consulted AdMa RI&TI users (particularly SMEs and start-ups) frequently described access fees as high, RI&TI operators emphasise that these costs are crucial to sustain facility operations. To address this, some RI&TIs offer targeted support to spin-offs and SMEs. For example, when it comes to individual discussion of fees, one quarter (25%) offers reduced access fees for SMEs, start-ups, or specific user groups. Other RI&TIs offer financial or in-kind assistance to SMEs to mitigate issues related to the affordability of fees. In addition, in some cases, RI&TIs navigate SMEs in helping them to access regional and national financial support schemes for infrastructure access, which can help offset access costs, especially for SME. **Nevertheless, AdMa RI&TI users note that such schemes remain limited in coverage. In some cases, rising operational expenses have led to fee increases, prompting companies to seek services in neighbouring countries.**

Other RI&TIs also apply a standard cost or usage fee structure for external users. In addition, RI&TI operators set fees per project based on a range of factors, including the type of personnel involved, duration of use, safety or toxicity requirements, and the rarity or complexity of the tests performed. In some cases, hourly rates and framework contracts offer flexible access and predictable costs for frequent users. Pricing structures often include overhead costs associated with maintaining advanced laboratory infrastructure, including energy-intensive equipment and facility upkeep.

However, SMEs, including start-ups, operate with limited budgets, making it difficult to afford advanced testing, prototyping, and consultancy services, which are often perceived as costly investments. While larger companies generally view access fees as manageable, **SMEs frequently identify cost as a barrier, especially when public support schemes are limited**. Several RI&TI users also noted that voucher schemes or dedicated funding programmes for SME access remain limited, despite their potential to lower entry barriers. This limited availability of TI access support hinders SME's ability to scale technological solutions from laboratory to pilot production, especially when R&I processes are lengthy and require specialised equipment.

Operational and organisational difficulties.

Accessing cutting-edge equipment often comes with scheduling constraints due to high demand, strict safety requirements, and the need for prior project planning. The pace and culture of scientific validation may not align with SMEs' fast-moving, market-driven timelines. In addition, **limited in-house resources, such as R&D staff, make it harder for SMEs to integrate research results into industrial processes.** This is also related to a lack of technical knowledge and expertise. For instance, many SMEs struggle to define their research needs, specify technical parameters. This knowledge gap also extends to regulatory understanding, IP management, and familiarity with international standards. Consequently, **SMEs often rely heavily on the expertise of RI&TI staff for technical guidance, experiment design, and data interpretation, dependencies that can raise costs and extend project durations**.

Other access barriers include:

- **Navigating complex procedures**, securing formal approvals, complying with safety standards for hazardous materials, and meeting documentation requirements.
- Regarding **alignment with market needs**, according to consulted SMEs, infrastructures were described as more research-driven rather than industry-oriented, with services not fully adapted to the applied and time-sensitive needs of SMEs.
- **Geographical and logistical factors**, such as long travel distances and limited remote access options, can deter smaller firms, particularly those outside major innovation hubs.
- **Regulatory and legal obstacles**, including state aid rules and restrictions on the commercial use of publicly funded R&I infrastructures, may also limit access, leading to under-utilisation of facilities. More specifically, while EU state aid rules (SARs) play an important role in ensuring fair competition in the internal market, stakeholders note that interpretation and implementation of these rules can create barriers for TIs seeking to provide broader access to industrial users. Several challenges arise from the current legal framework and its application across Member States:
    - **Uncertainty around the distinction between economic and non-economic activities**[57] [58]: TIs often combine publicly funded activities (e.g. research, education, skills development) with services provided to industry (e.g. contract research, testing, and prototyping). Determining which activities are considered "economic" under EU State aid rules is not always straightforward. This creates uncertainty for infrastructure operators when designing access models or pricing services for industrial users.
    - **Legal ambiguity regarding the status of Technology Infrastructures**: Current state aid frameworks do not explicitly define Technology Infrastructures and often associate them with "testing and experimentation infrastructures".[59] Given the diversity of TI business models and governance structures, this linkage can create uncertainty about which state aid provisions apply to investments and operations. This ambiguity can delay the development of funding programmes and discourage investment in new infrastructures.[60]
    - **Restrictions on providing services to industry**: When activities are classified as economic, TIs must ensure that services are provided under market conditions and in compliance with the provisions of the General Block Exemption Regulation (GBER). The GBER, which allows certain types of public funding to be granted without prior Commission approval, was updated in 2023 to expand aid scope, raise thresholds for R&D&I projects, and introduce provisions specifically covering testing and experimentation infrastructures.[61] However, stakeholders note that practical uncertainties remain regarding the interpretation and application of the provisions. These uncertainties can limit the flexibility of infrastructure operators to offer preferential access, reduced pricing, or targeted support schemes for companies (particularly SMEs, start-ups, and

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[57] EARTO (2025). EARTO responses to the EC consultation on GBER. https://www.earto.eu/wp-content/uploads/EARTO-Response-to-EC-Call-for-Evidence-on-GBER-Final.pdf

[58] EIB (2025). Unlocking innovation: Addressing the funding needs of EU Technology Infrastructures. https://www.eib.org/attachments/lucalli/20250208-150925-unlocking-innovation-en.pdf

[59] Council of the European Union (2025). Outcome of proceedings of the European Research Area and Innovation Committee (ERAC) plenary meeting, 12-13 June 2025, Gdansk - ERAC Opinion on Research Infrastructures (RIs) and Technology Infrastructures (TIs) in Europe. https://era.gv.at/public/documents/5346/Research_and_technology_Infrastructures_13_06_2025.pdf

[60] Retrieved from: https://www.cesaer.org/content/3-task-forces/2024-2025/task-force-openness-st/20250214-towards-a-european-policy-for-technology-infrastructures.pdf

[61] Commission Implementing Regulation (EU) 2023/167 of 6 July 2023 amending the General Block Exemption Regulation. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2023.167.01.0001.01.ENG&toc=OJ%3AL%3A2023%3A167%3ATOC

spin-offs), which can discourage industrial use of publicly funded infrastructures. The Commission is currently reviewing the GBER, with the goal of simplifying conditions, improving SME support, and reducing administrative burdens[62].

- **Divergent interpretation and implementation across Member States**: Stakeholders report that the understanding and application of state aid rules vary significantly between Member States, authorities, and TI operators.[63] [64] This can lead to inconsistent funding conditions, different approaches to cost recovery, or varying eligibility criteria for industry access. Such fragmentation creates additional administrative burdens and uncertainty, particularly for cross-border TI initiatives or infrastructures co-funded by multiple Member States. These variations should be harmonised to avoid Member States from applying the rules too strictly or creating inconsistencies between national funding conditions and EU regulations.[65]

- Overall, stakeholders stress the need for clearer and more consistent guidance on the application of EU state aid regulation to TIs. They call for clarification of the distinction between economic and non-economic activities, harmonised interpretation across Member States[66], and practical guidance on pricing, cost recovery, and access models that enable TIs to support industrial innovation while remaining compliant with EU competition rules. Moreover, several stakeholders call for the JRC's State Aid Decision Tree[67] to be updated to better reflect current best practices of applying state aid rules within TIs.[68] [69] In addition, the Expert Group on Technology Infrastructures suggested establishing an EU-level Community of Practice on state aid as part of TI governance. This platform would facilitate the exchange of experience in designing funding programmes compliant with SARs and provide guidance for setting up TIs in line with EU State aid legislation.[70]

* **IP and liability issues**, including unclear contractual frameworks, fragmented IP and licensing practices among TI providers, may create uncertainty for companies and discourage access.

* **Finally, many SMEs, start-ups and large companies are unaware of relevant facilities or underestimate the potential benefits of engaging with them**. While several

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[62] European Commission. Review of the General Block Exemption Regulation. https://competition-policy.ec.europa.eu/state-aid/gber-review_en

[63] EIB (2025). Unlocking innovation: Addressing the funding needs of EU Technology Infrastructures. https://www.eib.org/attachments/lucalli/20250208-150925-unlocking-innovation-en.pdf

[64] EARTO (2025). EARTO responses to the EC consultation on GBER. https://www.earto.eu/wp-content/uploads/EARTO-Response-to-EC-Call-for-Evidence-on-GBER-Final.pdf

[65] EARTO (2025), EARTO Response to the EC Consultation on a European Strategy on Research and Technology Infrastructures, https://www.earto.eu/wp-content/uploads/EARTO-Response-to-EC-Consultation-on-EU-strategy-on-RTIs-Final.pdf

[66] European Commission (2025). Towards a European Policy for Technology Infrastructures - Building Bridges to Competitiveness. https://www.cesaer.org/content/3-task-forces/2024-2025/task-force-openness-st/20250214-towards-a-european-policy-for-technology-infrastructures.pdf

[67] Joint Research Centre (2020). State aid rules in research, development & innovation – Addressing knowledge and awareness gaps among research and knowledge dissemination organisations: Decision tree. https://knowledge4policy.ec.europa.eu/projects-activities/guidance-form-decision-tree-state-aid-rules-research-development-innovation_en

[68] EARTO (2025), EARTO Response to the EC Consultation on a European Strategy on Research and Technology Infrastructures, https://www.earto.eu/wp-content/uploads/EARTO-Response-to-EC-Consultation-on-EU-strategy-on-RTIs-Final.pdf

[69] European Commission (2025). Towards a European Policy for Technology Infrastructures - Building Bridges to Competitiveness. https://www.cesaer.org/content/3-task-forces/2024-2025/task-force-openness-st/20250214-towards-a-european-policy-for-technology-infrastructures.pdf

[70] European Commission (2025). Towards a European Policy for Technology Infrastructures - Building Bridges to Competitiveness. https://www.cesaer.org/content/3-task-forces/2024-2025/task-force-openness-st/20250214-towards-a-european-policy-for-technology-infrastructures.pdf

infrastructures have developed communication and outreach mechanisms, **visibility remains fragmented, especially outside established networks and EU projects**.

In short, SMEs, including start-ups, play a vital role in driving innovation and Europe's technological sovereignty. Yet, as the findings show, they often face specific challenges when accessing RI&TIs, including financial constraints, complex administrative procedures, and limited tailored support.

4.1.3. Measures to improve access to Technology Infrastructures

At the organisational level, several consulted TIs have introduced **dedicated business units, technology-transfer units or industry liaison officers** to act as points of contact for industrial users. These structures help reduce administrative burden and improve SME access to TIs by translating complex technical capabilities into industry-friendly service package descriptions, and conducting targeted outreach to SMEs, start-ups and scale-ups. For example, Tekniker has a marketing, business and technology transfer unit addressing different technologies and sectors to act as contact points for industrial users. This structure assists in approaching companies, handling contracts and confidentiality agreements, reducing administrative burden, and supporting companies with any issues that arise. Another example is offered by DTI. There, all business-to-business activities are handled de-centrally by the consultants working across different technical centres at DTI.

As highlighted during the validation workshop, such interface functions are particularly valuable in helping companies navigate a fragmented infrastructure landscape and identify the most relevant services among multiple providers. The box below provides an illustrative example of a dedicated support service within a TI to facilitate SMEs' access to their services, TNO's Fast Track service.

Box 1 TNO's Fast Track service

TNO's Fast Track service provides tailored R&D and technical support to start-ups, scale-ups, and SMEs by giving them streamlined access to TNO's expertise and testing facilities. In practice, companies approach Fast Track with a specific business/technical challenge (e.g. validating a new concept or product testing), and TNO responds by mobilising the right experts and infrastructure. Through its website, TNO provides a Quick Scan, e.g. a quick online survey for industrial users to check whether they are eligible for support through Fast Track. An example of a company from the AdMa sector having accessed the service is CurTec, a designer and manufacturer of high-performance plastic packaging, which accessed the FastTrack service to assess the technical feasibility of a solution for their products.

Source: TNO Fast Track service, link, and CurTec's collaboration with Fast Track, Link

Beyond internal organisation, **proactive outreach and ecosystem building activities** play an important role in increasing awareness of RI&TI services, as illustrated by several consulted interviewees. European Digital Innovation Hubs (EDIHs) can act as effective intermediaries between SMEs and TIs; for instance, in Croatia, the CroboHub EDIH[71] supports SMEs and start-ups by connecting them with relevant public institutes and infrastructures and guiding them towards suitable services. This role is complemented by national and regional workshops and information days that provide SMEs with practical guidance on funding opportunities and infrastructure access. This point is related to a broader trend in the TI landscape, identified in the validation workshop, which concerns **a shift from passive availability of services toward proactive engagement with companies**, including showcasing capabilities, participating in industrial events, and tailoring communication to non-expert audiences.

[71] For more information on the EDIH, see: https://www.icent.hr/en/crobohub/

Workshop participants also highlighted the essential role played by **intermediaries** such as regional technology centres, Research and Technology Organisations, contract research organisations, and specialised SMEs. These actors help bridge cultural and technical gaps between companies and infrastructures by understanding industrial needs, assisting in the formulation of technical requests, and interpreting complex results. Acting as regional multipliers, intermediaries significantly improve visibility and increase the likelihood that SMEs will identify and engage with relevant TIs.

Flexible access modalities further contribute to lowering barriers, particularly for SMEs. In addition to direct fee-for-service contracts, many TIs enable access through publicly funded collaborative research and innovation projects, residency programmes or long-term partnership agreements. These models allow companies to benefit from subsidised access, shared risk and closer integration with TI expertise, while accommodating different levels of maturity and investment capacity. Evidence from surveyed infrastructures shows that offering a spectrum of access modes, rather than a one-size-fits-all approach, is particularly effective in supporting SME engagement. Several experts at the validation workshop further stressed the importance of clearly differentiating between standardised, short-term service offerings and more complex, long-term research collaborations. Establishing straightforward access pathways for common services enables rapid response to industrial needs, while maintaining options for deeper collaboration preserves scientific depth and relevance for more demanding projects.

Administrative and procedural simplification is another key enabler of access. Clear, standardised contracts that transparently define roles, responsibilities, IP arrangements, confidentiality, data protection and liability can significantly reduce negotiation time and uncertainty for users. Such frameworks help build trust, especially when commercially sensitive information is involved, and make TI services more accessible to companies with limited legal or administrative resources.

Financial support measures remain among the most important tools to facilitate access, especially for SMEs and start-ups. Stakeholders highlight the value of voucher schemes, innovation grants and reduced-cost access for early-stage testing and piloting. Examples from national and regional programmes show that relatively small vouchers can effectively lower entry barriers and enable companies to demonstrate proof of concept or value generation. Box 2 below provides an example of a regional innovation voucher scheme supporting SME access to TIs. As discussed during the validation workshop, voucher schemes were widely acknowledged as particularly effective instruments for enabling SME access while remaining compliant with state aid rules. They support short, well-defined work packages and are well-suited to situations where time and cost constraints are critical. Some experts also pointed to positive experiences from large-scale European programmes, where vouchers enabled efficient, targeted collaboration and broad SME participation.

Box 2 Regional innovation vouchers supporting SME access to RI&TIs – the Baden-Württemberg example

> In the German state of Baden-Württemberg, a regional ***Innovation Voucher*** scheme supports SMEs and start-ups in accessing external research and innovation services, including services provided by RIs and TIs. Through this programme, companies can receive vouchers ranging from approximately €7.5k to €20k, covering up to 50% of eligible costs related to innovation activities such as external R&D, testing, and technical development. The scheme is managed by the regional development bank and is designed to reduce financial risk and lower entry barriers for SMEs seeking to collaborate with external expertise and facilities. This example illustrates how regionally administered voucher schemes can provide flexible and targeted financial support to facilitate SME access to RI&TI services.

Source: Innovationsgutscheine Baden-Württemberg, Link

Some TIs also propose allocating part of their capacity through light, competitive selection processes, similar to research funding calls, to ensure fair and efficient use of resources.

However, the availability and design of such schemes vary widely across Member States, leading to uneven access conditions across Europe.

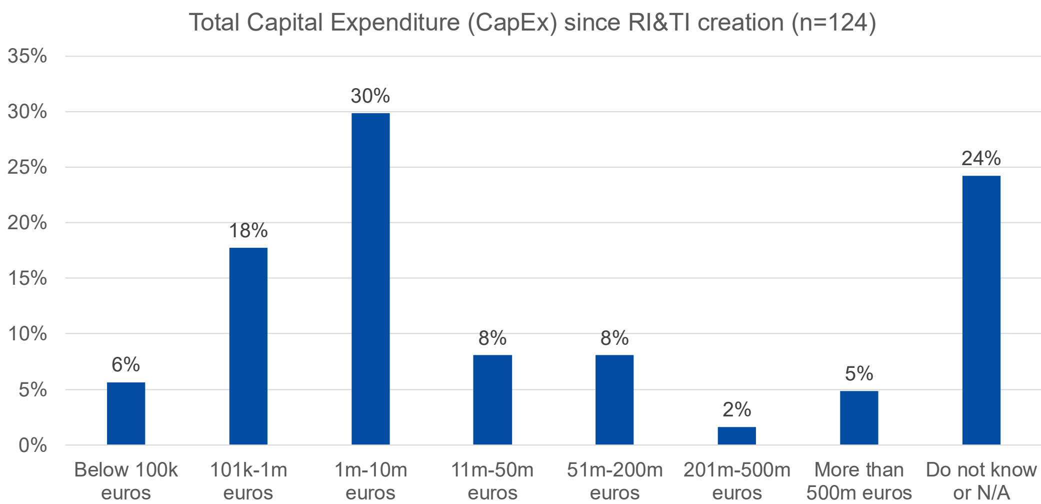
Finally, several measures can help **facilitate cross-border access to TIs**. Increased cooperation and interoperability between infrastructures can support transnational, multisite and cross-sectoral use of services, including through shared standards, aligned administrative processes and FAIR data practices. Virtual and remote access services, such as digital simulations, remote data analysis and hybrid access models combining off-site and on-site activities, can help overcome geographical and logistical barriers. Mobility schemes for researchers and technicians, as well as local intermediaries supporting companies in accessing infrastructures abroad, further contribute to strengthening cross-border collaboration and making TI services more accessible across the Union.

4.2. Funding & long-term sustainability and investments needed to set up successful infrastructures

4.2.1. Capital investment into the development and upgrade of AdMa RI&TIs

Capital expenditures (CAPEX) are the funds RI&TI operators allocate to develop, upgrade, and maintain research and/or Technology Infrastructures. By investing in fixed assets, such as building a new facility, pilot line or upgrading an already existing one, RI&TI operators aim to enhance their operations, ensuring sustained growth and competitive advantage. The figure below provides a more detailed split of CAPEX investments.

Figure 12 Total Capital Expenditure (CAPEX) since RI&TI creation.



Source: Technopolis Group, based on AdMa RI&TI survey results.

Overall, 30% of surveyed RI&TIs **have invested between €1m-€10m** in creating infrastructure focused on AdMa. A **significant share (18%)** of RI&TIs invested **between €101k-€1m**. While **large-scale investments (above €200m)** were made **by 7%** of surveyed RI&TIs.

To upgrade their facilities, continuous CAPEX investments are necessary. For example, over the next five years surveyed AdMa TIs will need at least €0.9-€2.1b in investment. This corresponds to 8-12% of the necessary investments for upgrading all TIs in the EU

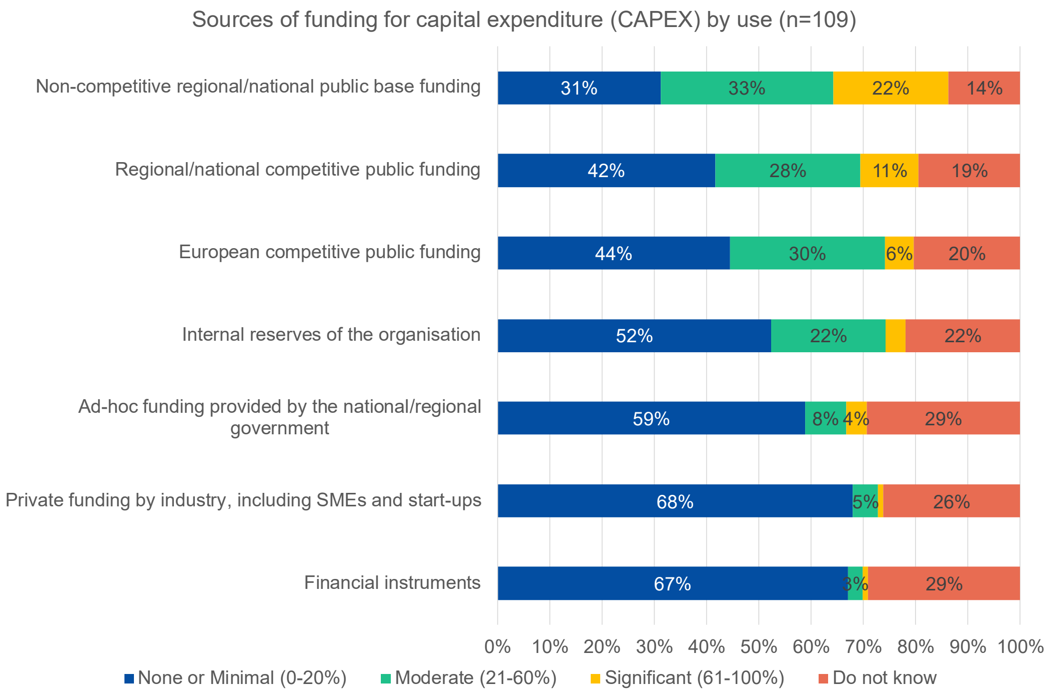
as identified by the European Investment Bank[72]. According to the consulted AdMa TI providers, **to ensure infrastructures remain state-of-the-art and continue to effectively serve users over the next five years, these investments are essential**. RI&TI providers indicate that necessary investments encompass, for example:

- **Purchasing new equipment, expanding the scope of offered services** (e.g. a TI plans to purchase a recycling bath for vitrimers, enabling processing of larger-scale samples. These investments are necessary to broaden the application range of bio-based and recyclable polymers)
- **Optimising provided services** (e.g. investment into state-of-the-art microfluidic production and purification systems for nanomedicines, e.g. advanced mixing devices and tangential flow filtration system). This aims to establish a pilot production lab for optimising small-scale production of nanomedicines in a non-GMP (Good Manufacturing Practices) environment.
- **Installation of new power supply and energy systems** (e.g. to increase energy power capacity, expanding the scope of operations).

In general, **the RI&TI upgrades are planned to enable the infrastructure to better respond to industrial partner needs (including SMEs). The upgrades also contribute to addressing the digital and green transitions.**

To finance the CAPEX expenditure in building and upgrading infrastructure, RIs more often rely on public funding, while TIs rely on a mix of funding sources, consisting of public funding (regional or national), public-private funding, and public/loan models. This is reflected in the survey results of the AdMa RI&TI providers (see below).

Figure 13 Sources of funding to support the capital expenditures (CAPEX) by use.



[72] EIB (2025): Unlocking innovation – Addressing the funding needs of EU Technology Infrastructures. Retrieved from: https://www.eib.org/en/publications/20250208-unlocking-innovation-addressing-the-funding-needs-of-eu-technology-infrastructures

Source: Technopolis Group, based on AdMa RI&TI survey results.

The funding mix for capital expenditure varies, depending on the type of infrastructure (RI or TI), the country of operation (e.g. availability of regional funds) and business model (e.g. strong industrial user base). In terms of the main funding sources in the funding mix for RI&TIs focused on AdMa:

- The **most widely used source of funding** is **regional or national public base or block funding** provided directly by governments.
- **Competitive public funding**, both at the EU and national/regional level has an **important role.** EU programmes such as Horizon Europe were indicated as important. In terms of national and regional competitive public grants, 11% of respondents indicated these funds are a substantial contributor to CAPEX.
- **Ad-hoc funding from national or regional governments** and the **use of internal reserves** from organisations also have a **moderate weight** in the funding mix.
- **Income generated from the private sector** is generally less often used to finance CAPEX. Similarly, **financial instruments** such as loans or equity provided by banks or EU/national institutions **were largely not used by surveyed RI&TIs**.

This closely follows the findings of the funding needs reports identifying a strong reliance on traditional public funding channels for capital investments in TIs, while alternative financial instruments and private funding sources remain underutilised, indicating opportunities for diversification and improved financial planning[73].

Nevertheless, the surveyed RI&TIs that focus on AdMa indicate that available funding for capital investment is not sufficient to address the upgrade needs. There is a CAPEX investment gap at least ranging between €0.2-€0.8b. This is the gap in funding that the surveyed RI&TIs were unable to raise on average per year over the past five years to fund the CAPEX for the creation and / or upgrade of RI&TIs focused on AdMa. In relation to limited availability of public funding and other funding streams for CAPEX, consulted stakeholders identified other challenges such as difficulty in combining funding from different sources, the limited predictability of funding sources, barriers in securing private funding and the large scale of initial costs for setting up and upgrading facilities.

4.2.2. Operational expenditure related to running AdMa RI&TIs

Operating expenditure (OPEX) is an expense that an AdMa RI&TIs incurs through their day-to-day operations, for instance, marketing, payroll, insurance and utilities.

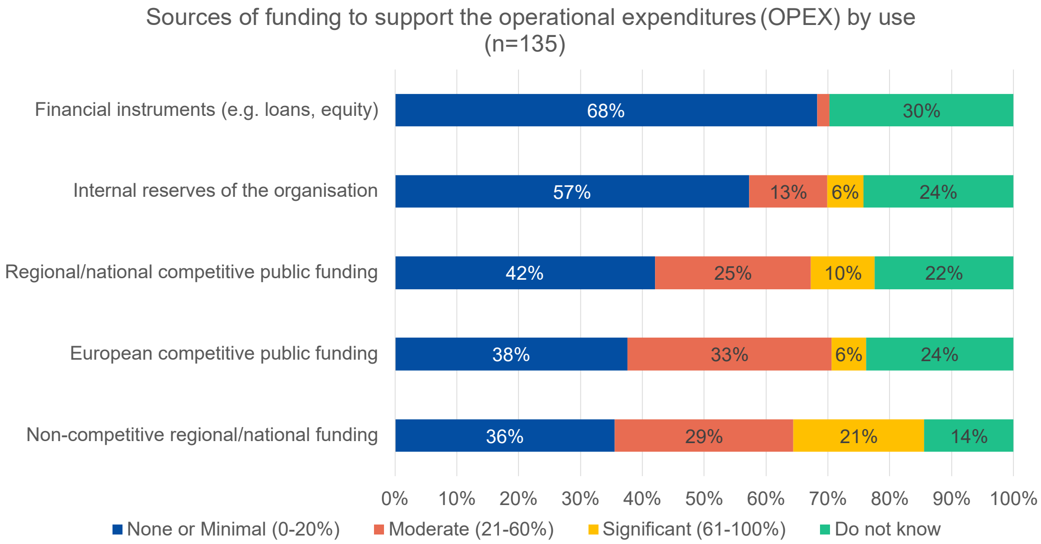
Overall, for 18% of the surveyed AdMa RI&TIs, the OPEX has ranged on average between €50k-€200k per year over the past five years. Smaller but notable proportions of infrastructure providers reported spending below €50k (13%) and €200k-€500k (12%). 10% of surveyed AdMa RI&TIs indicated costs of €500k -€1m , and 14% reporting yearly operational costs exceeding €1m (see Figure 25).

However, the **OPEX varies widely depending on the infrastructure type**[74]. Depending on their business model, AdMa RI&TIs cover a share of the operational costs using income generated from provided services. However, **only a handful of consulted AdMa RI&TIs can fully cover their operational expenses**. For example, some RI&TIs indicated that only ~20-30% of annual operational costs are covered by revenues generated from service provision (e.g. characterisation, prototyping, small-series production for external users, including SMEs and

[73] European Investment Bank, Unlocking innovation – Addressing the funding needs of EU Technology Infrastructures, European Investment Bank, 2025, https://data.europa.eu/doi/10.2867/6078045
[74] European Investment Bank, Unlocking innovation – Addressing the funding needs of EU Technology Infrastructures, European Investment Bank, 2025, https://data.europa.eu/doi/10.2867/6078045

industry). **The remaining operational costs** are covered by a **mix of public and private funding and internal reserves of the organisation (e.g. reinvestment of profit) (see figure below for more detailed breakdown).**

Figure 14 Sources of funding to support the operational expenditures (OPEX) by use



Source: Technopolis Group, based on AdMa RI&TI survey results.

More specifically:

- **Non-competitive regional/national public base funding and/or Government Base/Appropriation/Block Funding** directly provided by regional/national government covered between 20-100% of OPEX for 50% of surveyed AdMa RI&TIs.
- **Financial instruments, such as loans and equity, are not used at all by most RI&TIs (68%).** Only a small proportion (7–8%) reported using them to cover between 1-20% of their operational expenses.
- About half of the respondents indicated that they made no use of internal reserves of organisations, such as reinvested profits.

Despite the availability of non-competitive regional/national public base funding, AdMa RI&TIs indicated they face significant challenges related to covering OPEX. The challenges include low funding rates in national/EU and regional programmes, increased costs due to inflation and rising energy costs and insufficient demand to fully utilise the capacity of the infrastructures.

5. AdMa RI&TI collaboration modalities and guidance for increased collaboration

AdMa RI&TIs collaborate with other RI&TIs, industry and other EU initiatives (e.g. OITBs, EDIH, Chip Pilot Lines). To collaborate, RI&TIs employ several contractual models with external partners. The figure below provides an overview of the adopted collaboration models.

Figure 15 Cooperation modalities employed by RI&TIs.

Source: Technopolis Group, based on AdMa RI&TIS survey results. Values do not add to 100% due to multiple-choice answers.

The most common form of collaboration is direct bilateral projects or contracts. This suggests that one-on-one partnerships are the main model for collaboration, followed by **collaborative projects** within publicly funded programmes, reported by 88% of respondents. **Long-term partnerships or collaboration agreements** are also widely adopted, with 75% of respondents engaging in these sustained forms of cooperation. More than half (51%) of RI&TIs participate in **PhD or research mobility programmes**, showing a commitment to capacity building and researcher exchange. Similarly, 46% engage through **memoranda of understanding** (MoUs), reflecting a preference for formalised yet flexible agreements. Less common modalities include use against a fee service (30%), residency programmes (17%), and sponsorships (10%). Only 8% report co-ownership of research or Technology Infrastructures under specific conditions.

The following sections provide a more in-depth analysis of collaboration modalities between AdMa RI&TIs and include suggestions for improving the collaboration dynamics.

5.1. Collaboration between RI&TIs

The analysis of collaboration between RIs and TIs draws on desk research and three interviews with RIs and TIs involved in the EASI-STRESS project. It also includes the insights from the stakeholder workshop organised within the framework of this study[75]. The analysis revealed that **RIs and TIs collaboration often draws on long-standing cooperation and mutual trust, a good understanding of the interests, needs and constraints of organisations involved, and is mostly project-driven** (e.g. collaboration within a publicly funded, often EU-funded, projects). The analysis also points to **the untapped potential of a "bundled" service offering from the RIs and TIs** to cover a broader TRL range, accelerate the technology development, and more effectively support the commercialisation of new technologies. For this, harmonisation of access conditions, procedures, data, IP rules, and other procedural aspects across RIs and

[75] The validation workshop on 14 January gathered inputs from RIs and TIs representatives.

TIs is needed. In addition, a **clear delimitation of services to be provided by each partner within the collaboration** is crucial to avoid duplications and inefficiencies.

Nevertheless, several challenges limit the RIs and TIs collaboration:

- **Fragmented governance frameworks and lack of coordinated mandates**: RIs and TIs operate under diverse governance models, funding rules and institutional mandates. At the EU and national levels, no formal coordination body exists for TIs, and their relationship to RI governance structures such as ESFRI remains unclear. This institutional fragmentation limits strategic alignment and complicates collaboration.
- **Competition for funding and resources**: Infrastructures often compete for funding streams and users. Moreover, some RIs indicate that increased support for TIs may reduce funding opportunities for them. This competition discourages joint efforts and reduces incentives for collaboration.
- **Lack of harmonised access rules, administrative complexity and incompatible IP frameworks**: Differences in access procedures, data management policies and IP practices create barriers for joint projects. The coexistence of open access requirements (common in RIs) and confidentiality requirements (critical for TIs and industry) complicates cooperation.
- **Legislative and jurisdictional inconsistencies across countries**: Different national legal frameworks for IP, data, liability and confidentiality hinder cross-border collaboration. The lack of harmonised regulations or shared standards makes it difficult for infrastructures to develop coordinated services or long-term partnerships.
- **Limited mutual awareness, insufficient mapping and unclear contact points**: infrastructures often lack knowledge of each other's capabilities, instruments or services provided. Without a clear overview of TIs compatibility with existing RIs, opportunities for synergy remain underexploited.

Going forward, the RIs and TIs collaboration could be strengthened by:

- **Preparing a combined service offering to companies** to attract more users and accelerate the industrial deployment of new technologies (incl. via staff training, building trust, clear roles division and strategic vision for the services provision anchored at the organisational level.
- **Strengthening skills development, training and cross-learning**: joint staff competencies development would increase mutual understanding, reduce cultural barriers and foster the emergence of staff who understand both research- and industry-oriented infrastructures.
- **Launching pilot collaboration projects**: initiating pilot projects where RIs and TIs jointly develop new services (e.g. a chemistry TI and a synchrotron co-developing a catalyst characterisation service).
- **Establishing shared guidelines, harmonised access rules and coordination mechanisms**: Developing common guidelines for access conditions, cost models, data treatment, IP rules and service delivery would reduce administrative burdens for collaboration.
- **Improving mapping, coordination and strategic planning**: A structured mapping of TIs similar to RI landscaping exercises would help clarify capabilities and complementarities between facilities. Annual gatherings, RI-TI summits and joint foresight exercises would support coordination efforts.
- **Testing hybrid or co-financing schemes**, including aligning multiple funding streams to enable RIs and TIs cooperation. Dedicated funding calls that require or reward RI-TI partnerships would help reduce competition and promote collaboration. Examples include

combined service development projects, shared access schemes or calls under programmes such as INFRA SERV that explicitly support integrated service delivery.

- **Utilise digital tools for remote collaboration**: Expanding digital tools, modelling integration and virtual access mechanisms would help link RIs and TIs more effectively across the EU. Digitalisation also enables new formats of collaboration, such as shared digital twins, virtual training and distributed workflows.

5.2. TI Cross-border collaboration

The analysis of TIs collaboration across borders revealed that while the benefits of such collaboration are substantial (e.g. pooling resources to avoid duplications, enabling access to better, specialised and otherwise costly facilities to innovators, enhancing territorial cohesion), it has been rather limited in practice.

For instance, the **Solliance partnership,** which builds on a strong collaboration between TNO (NL) and Imec (BE) in photovoltaics, provides a few insights into successful cross-border TI collaboration. In fact, the **strong involvement of regional governments and the private sector** (e.g. Philips, ASML) **were key to catalysing this collaboration**. The regional government invested in Solliance' facilities development (€28 m) at the start and industry formulates the demand for specific service provision (e.g. building an "Imec" equivalent in the Netherlands). In addition, **mobilisation of multiple funding sources** (e.g. Interreg, HE, national/ regional funding) throughout the 10+ years partnership contributed to its sustainability, drawing on **strong innovation ecosystems and industrial base of the regions** involved.

Nevertheless, several challenges limit the cross-border TI collaboration:

- **Fragmented and unsynchronised funding landscapes**: Cross-border collaboration often requires parallel investment from several countries or regions, yet funding timelines, eligibility rules and strategic priorities are rarely aligned. Misaligned calls and inconsistent regional or national funding instruments make it difficult to develop joint initiatives or sustain shared facilities over time. Short-term project-based funding further inhibits long-term joint planning and does not provide stable resources for collaboration across borders.

- **State aid constraints and regulatory inconsistencies**: State aid rules were cited as a major barrier when cross-border activities involve mixed funding or support to SMEs. Different national interpretations, as well as varying legal and administrative frameworks for IP, data and liability, make it difficult to structure cooperation agreements. These legislative disparities create uncertainty for infrastructures and industrial users.

- **Competitive dynamics and limited incentives to collaborate**: Experts noted that national or regional TIs are typically designed to boost local competitiveness and therefore lack incentives to cooperate internationally. Competition for funding, industrial clients and visibility can discourage collaboration.

- **Asymmetries in industrial capabilities and ecosystem maturity**: Differences in industrial development levels across regions create structural barriers. TIs in less industrialised ecosystems may lack the capacity to contribute fully to cross-border initiatives, while more advanced regions may find cooperation less beneficial. These asymmetries can undermine balanced collaboration and limit opportunities for shared investment.

- **Limited knowledge of other TIs' capabilities and ecosystems**: Experts highlighted insufficient awareness of the broader European TI landscape. Without clear mapping or transparency on capabilities, TIs struggle to identify complementary partners and avoid duplication. Language barriers, cultural differences and limited personal networks further constrain cooperation, especially for SMEs attempting to access foreign TIs.

- **Sensitivity of proprietary information and confidentiality requirements**: Sharing proprietary knowledge is often essential for effective collaboration, but companies and infrastructures remain cautious about disclosing confidential information across borders. This concern, combined with inconsistent IP and confidentiality frameworks, can slow down or prevent cooperation.

To strengthen and scale cross-border collaboration between TIs, the following measures could be pursued:

- **Aligning and coordinating funding instruments across regions and countries**: Synchronised calls, co-funded programmes and joint programming efforts could be effective, as cross-border TIs collaboration requires predictable revenue models and multi-annual funding arrangements at EU and national levels. Moving from project-driven to programmatic collaboration would provide greater long-term stability.
- **Engaging regional authorities and industry in joint planning**: Cross-border collaboration requires active involvement of regional governments and industrial partners. Regional authorities could commit funding beyond project lifetime and participate in shared strategic planning. Stronger industry participation would help ensure alignment with real market needs.
- **Improving coordination and ecosystem-level planning**: Better coordination at EU and transnational levels could reduce duplication, support clustering and foster specialisation. Joint foresight exercises, shared roadmaps and cross-border ecosystem strategies, including the use of S3 frameworks, could be developed to address common industrial challenges and support cross-border TI collaboration.
- **Foster knowledge exchange and trust-building activities**: Regular gatherings, cross-border workshops and exchanges of good practices are important measures to build trust, strengthen personal networks and increase awareness of complementary capabilities. Training programmes that help professionals understand different national contexts and collaboration models would further support cross-border engagement.
- **Clarify IP ownership and data sharing frameworks**: To facilitate cooperation, experts emphasised the need for clearer rules on joint IP, confidentiality and data access. Harmonised guidelines or model agreements would significantly reduce legal uncertainty and help TIs collaborate more effectively.

5.3. Other RI&TI collaboration with OITBs

The Open Innovation Test Beds (OITBs) are TIs in the European R&I and industrial ecosystem. **They are funded by Horizon Europe (previously Horizon 2020) to support a future-proof industrial development of AdMa in Europe.**[76] The OITBs bring together academia, Research and Technology Organisations (RTOs) and companies in a consortium with a single-entry point (SEP). SEPs offer open access to testing and experimentation spaces, in particular for SMEs[77]. OITBs include both digital and physical facilities required to develop, test and upscale AdMa, and in this way to move from validation in laboratories (TRL 4) to prototypes in industrial environments (TRL 7).

Data from the OITB analysis demonstrates the innovation impacts that the platform achieved. In total, 44% of the OITBs have generated patents. Furthermore, 29% of the OITBs have performed three pre-standardisation activities or revisions of existing ones, 14% have performed

[76] Open innovation test beds for Advanced Materials – Examples and lessons learnt from one type of Technology Infrastructure, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2777/28908
[77] Retrieved from: https://cordis.europa.eu/article/id/436434-open-innovation-test-beds-to-accelerate-european-innovation

two, and 57% have performed one[78]. Another key added value of the OITBs is that these initiatives provide access to TIs, bridging the gap created by fragmented landscapes of these infrastructures across Member States[79].

In terms of attracting users, the interviewed OITBs indicated that they operate an open service model. SEPs of the OITB typically scout relevant companies, introduce facilities, and assemble partner configurations that provide the required service. Interviewed OITBs noted that for new user outreach, proactive market research, scoping calls and early contact are essential.

By design, an OITB starts as a consortium of many partners (companies, research institutes, universities, etc.) spread across at least three countries. Managing such a network as a cohesive service provider is inherently challenging**. Aligning the interests and contributions of dozens of institutions requires strong governance**. As reported by an OITB manager, the main barriers arise from the need to reconcile the interests of all partners and be able to create a single-entry point that integrates all the platform's services and capabilities[80].

Another challenge relates to the geographic positioning. By their nature, OITBs aim to serve all of the EU, however, test beds are physically located in specific regions, and attracting users from other countries involves additional barriers (travel/logistics, cross-border contracts, etc.).

When it comes to collaboration between RI&TIs and OITBs, the following barriers emerge:

- **Concerns around sharing proprietary information**: A recurring barrier is the uncertainty over whether and how proprietary or commercially sensitive information can be shared. Both infrastructures and industry users may hesitate to collaborate when confidentiality terms are unclear or when knowledge exchange is perceived as risky.
- **Limited knowledge and visibility of each other's instruments and roles**: RI&TIs report a lack of awareness of what OITBs are, what they do and how they operate.
- **Competition with other RI&TIs**: RI&TIs outside the OITBs may end up competing for the same industrial customers. This competition reduces incentives to collaborate and can create tension when infrastructures target similar markets.
- **Lack of dedicated funding instruments to support collaboration**: There is no clear funding mechanism enabling RI&TIs and OITBs to collaborate or to learn from each other. The absence of schemes designed specifically to facilitate TI-OITB cooperation limits joint activities.

Moreover, the OITBs face several challenges related to their financial sustainability. The original model envisioned that, after the initial EU grant (typically 4-5 years), an OITB would become self-financing by providing services to industry on a fee-for-service or membership basis[81]. In practice, this goal has proven difficult to attain for the first generation of test beds. Several interconnected challenges impact OITBs' funding and sustainability:

- **There is a limited industry demand for the offered services.** A critical challenge has been generating sufficient demand from industry clients to fill the revenue gap left by public funding. Many OITBs face difficulties in attracting users. Several factors contribute to this: SMEs often are not aware such services exist, or they may find the access process bureaucratic; some companies are hesitant to trust external entities with their proprietary

[78] European Commission, Directorate-General for Research and Innovation (2023), "Open Innovation Test Beds for Advanced Materials", doi: 10.2777/28908, p.22
[79] Open innovation test beds for Advanced Materials – Examples and lessons learnt from one type of Technology Infrastructure, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2777/28908
[80] Retrieved from: https://www.asebio.com/en/news-events/news/biospain2023-interview-open-innovation-test-beds-oitbs-are-inherently
[81] Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/0aaf1e05-2082-11ee-94cb-01aa75ed71a1/language-en

information (concerns about IP or confidentiality); many SMEs simply cannot afford the fees without support. Thus, a test bed's ability to help clients secure financing for test services (e.g. via vouchers or grants) is seen as advantageous in the long term.[82]

- **In the absence of a strong industrial demand, OITB consortia have often turned to follow-up public funding** – whether new EU projects, national programmes, or regional funds – to support their activities. According to the interviewees, this project-to-project funding approach is not a stable business model. It can lead to discontinuity (if no new grant is won) or mission drift (chasing funding calls rather than focusing on core services).

Strengthening collaboration between RI&TIs and OITBs requires **clearer strategic alignment, more explicit operational pathways and incentives that transform informal contacts into concrete joint activities.** Although collaboration is widely recognised as valuable, stakeholders have indicated during interviews that interactions with OITBs remain limited to ad hoc exchanges, promotional outreach or informal referrals.

One recommendation is the **creation of a joint roadmap to identify complementarities with other RI&TIs and OITBs**. Anchored in European strategic priorities such as batteries, semiconductors, space, hydrogen and other AdMa applications, the roadmap should define shared priorities, value-chain gaps, TRL and CRL levels where RI&TI capabilities can connect with OITBs. To reach neutrality and avoid institutional bias, the roadmapping process should be led by actors operating above individual organisational interests, such as neutral coordination bodies, specialised agencies or national/European level industry alliances. Translating strategic ambitions into operational practice, the roadmap should also set out common onboarding protocols for SMEs and industrial users.

To ensure that intensified collaboration leads to measurable progress, a **concise and shared set of indicators should be introduced**. These should track the frequency and the quality of structured information exchanges, such as regular coordination meetings with documented outcomes, the number of opportunities introduced and converted into projects or paid services, the volume and shares of cross-OITB and cross-RI&TI projects using multi-site service portfolios, and the number of joint funding programmes identified and accessed.

To ensure consistency and enable scale, partners should jointly craft **conceptual collaboration infrastructures that standardise core processes and embed systematic measurement**. This includes shared definitions and performance indicators (e.g. time-to-contract, time-to-test, utilisation rates and access across firm sizes and regions), profiling tools to map infrastructure capability to user needs, and matchmaking mechanisms that identify bottlenecks where RI&TI access is critical. These elements would directly respond to stakeholder needs, stressing the importance of knowing potential partners and the difficulty SMEs face in navigating fragmented infrastructure landscapes. Governance should also include pre-agreed IP and data-sharing frameworks to lower negotiation friction and attract active industrial partners.

Improved communication and engagement across the ecosystem are equally important. A **shared taxonomy for AdMa capabilities, services and use cases** would enable actors in different countries and parts of the value chain to navigate more fluently in the ecosystem. Organising services by TRL or CRL levels, application sector and service category would significantly increase transparency.

Stakeholders pointed out several actions that could significantly improve the collaboration:

- **Creation of a joint roadmap to identify complementarities with other RI&TIs and OITBs**
- **Greater clarity and proactive incentives for cross-initiative cooperation**. A partnering playbook specifying roles at each TRL stage, thresholds for referrals and funding or fee structures would support more predictable and effective collaboration.

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[82] Retrieved from: https://www.biomac-oitb.eu/en/normal/28/ViewBlogArticle

- **Simplified proposal and onboarding processes** are required. Measures such as pre-vetted partners, standard NDAs, micro-grant schemes with rolling deadlines and short pitch-based entry points could accelerate initial engagement.
- **Regional intermediaries** should be recognised as valuable contributors to European-scale OITB-RI&TI collaboration. Many stakeholders have already engaged effectively with regional RTO clusters, Digital Innovation Hubs and test-before-invest programmes.
- **Collaboration can be strengthened through cross-disciplinary and cross-facility networks**. Many stakeholders consulted already benefited from participation in established European consortia and projects, which foster trust, promote common standards and support staff exchange. OITBs can help fill gaps where national structures are weaker by convening mixed cohorts of RI&TI laboratories and industry around mission-driven themes. Jointly designed scale-up pathways can help bridge TRL gaps and provide a visible route from laboratory validation to industrial demonstration (e.g. scale-up sprints, combining pilot-line access with public micro-grants, DIH vouchers, etc.).

5.4. RI&TI collaboration with EDIHs and other digital initiatives

European Digital Innovation Hubs (EDIHs) are funded by the EU, national, and regional authorities and **provide digitalisation services to SMEs and the public sector**.[83] **EDIHs support AdMa development by assisting with the digitalisation of materials**.[84]

While the EDIH catalogue does not enable filtering of EDIHs based on the Advanced Material category, sectoral application options allow to narrowing down the scope. In general, there are 43 EDIHs focused on polymers and plastics and non-metallic materials & basic processes across the EU. These EDIHs are mainly distributed in Germany (6 entries), followed by Spain (5) and Italy (5). **Most hubs provide test-before-invest capabilities (pilots, proofs of concept, access to demonstrators and test beds, prototyping including additive manufacturing/3D printing, simulations and digital twins, and often HPC-as-a-service).** They pair this with advisory and assessment services such as digital maturity checks, roadmapping and strategy development, technology scouting, cybersecurity/readiness audits, and productivity/lean consulting. Many of these EDIHs explicitly connect their outcomes to the green transition. For example, increased energy efficiency, waste reduction/circularity, greener materials and processes.

The table below lists several examples of EDIHs in the EU that have a specialisation in AdMa (as a key enabling technology or focus area), along with their location, industry scope, services, coverage, funding and partner AdMa RI&TIs.

Table 3 Examples of EDIHs focused on AdMa and AdMa RI&TIs involved.

EDIH name	Country & region	AdMa specialisation	Examples of AdMa RI&TIs involved
EDIH SILESIA	Poland – Silesia region	Focus on incremental technologies and new materials for 3D printing	Technopark Gliwice Science and Technology Park

[83] Retrieved from: https://entire-edih.ie/wp-content/uploads/2025/04/ENTIRE-Enabling-Digital-Transformation-Webinar-7-April-2025-2.pdf
[84] Retrieved from: https://www.indtech2025.eu/wp-content/uploads/2025/07/Digitalisation-of-advanced-materials-Natalia-Konchakova.pdf

Basque Digital Innovation Hub (BDIH)	Spain – Basque Country	**AdMa node:** Innovation in new materials for Basque industry (e.g. developing composites, nanomaterials, advanced surface treatments) as part of its key enabling tech focus.	**CIC biomaGUNE** – Facilities for advanced fabrication and characterisation of biomaterials
POLYTRONICS (Smart Polymer & Digital Tech Hub)	France – Auvergne-Rhône-Alpes, Bourgogne-Franche-Comté, Centre-Val de Loire (multi-region)	**Smart polymers & Advanced Materials:** Supports the digitalisation of polymer **materials industries** (plastics, composites, textiles, rubber) using AI, cybersecurity and HPC. Focus on integrating AI to innovate sustainable and intelligent materials ("AI for sustainable and innovative materials").	**Industrial Technical Centre for Plastics and Composites (IPC)** – Pilot lines: injection, thermoforming, pultrusion, RTM, quality control islands, etc.
EDIH NEB (Northern and Eastern Bohemia)	Czechia – Liberec & Hradec Králové regions (regional)	**Nanomaterials & advanced tech:** EDIH provides digital innovation services in materials processing (e.g. textiles, glass)	**Technical University of Liberec** – Digital Slingshot test bed
Mazovia EDIH (Mazowieckie Digital Innovation Hub)	Poland – Mazowieckie (Mazovia) region, incl. Warsaw (regional/national)	**Microelectronics, photonics & advanced manufacturing:** Combines key enabling technologies **micro/nano-electronics**, electronic components, and photonics – with advanced digital tech (AI, HPC, cybersecurity) to accelerate the digital and green transformation of industry.	Centre for Advanced Materials and Technologies at Warsaw University **CEZAMAT** – semiconductor laboratories
CROBOHUB (Croatian Robotics DIH)	Croatia – national (Zagreb-based, with SEE outreach)	**Advanced robotics & materials synergy:** Focused on **fostering synergies between digital and other key enabling technologies (Advanced Materials)**. This ensures robotics innovations leverage cutting-edge materials (e.g. smart materials,	Innovation Centre Nikola Tesla in Zagreb **ICENT** – Laboratory for Autonomous Systems and Mobile Robotics

		lightweight composites) when relevant.	

Source: Technopolis Group.

The growing use of digital twins, AI-assisted modelling and data-intensive approaches in AdMa creates a **strong demand for shared competence development**. Interviewees expressed interest in joint training initiatives, workshops and staff exchange schemes that combine materials expertise with digital skills. Other pilot activities, such as co-hosted events, training programmes, staff exchanges and foresight or technology roadmapping exercises, could support strengthening capabilities across the ecosystem and further deepening trust and building durable working relationships between the RI&TIs and EDIHs.

Consulted stakeholders have also highlighted that regions with established EDIH ecosystems show that close collaboration can effectively support SMEs, particularly through test-before-invest schemes and public co-funding mechanisms. Documenting and benchmarking these successful models, and scaling them across other European regions, could significantly improve consistency and impact at the EU level.

However, several challenges remain. The most significant one faced by EDIHs relates to the continuity of funding. Interviewed EDIHs stated that their ability to support SMEs is **highly dependent on funding from the EU/national governments**. Without such support, companies in the pre-commercial phase would be unable to afford the services provided, and the continuity of the EDIHs would be challenged. Another challenge cited by one EDIH is that EU funding (as well as national funding that draws on EU funds) requires **significant administrative efforts**. Another EDIH also cited **outreach constraints** caused by domestic regulation of state-owned companies as hampering its ability to promote services effectively.

Several RI&TIs also reported **limited awareness of what EDIHs offer or how collaboration could be operationalised.** In many cases, interactions have been restricted to promotional outreach or initial contact without progressing to joint activity. EDIHs could therefore benefit from clearer communication of their value proposition for AdMa, particularly regarding test-before-invest services, digital twins, modelling and simulation capabilities and access to digital infrastructures. Enhanced catalogue functionality, thematic mapping of EDIHs active in the sector and targeted brokerage or matchmaking events would help RI&TIs identify relevant hubs and concrete entry points for collaboration.

Both RI&TIs and EDIHs stressed that **collaboration is often project-driven and tends to end abruptly when funding stops.** This discontinuity undermines trust, disrupts promising cooperation and limits long-term planning. Introducing phased or tapering funding models, combined with simplified administrative requirements, would help sustain collaboration beyond individual project cycles and make participation more attractive, especially for resource-constrained organisations.

Overall, to increase the collaboration between RI&TIs, EDIHS and other digital initiatives, the following measures should be pursued:

- **Harmonise methods, data formats and technical approaches**: developing common methodologies, aligned formats and interoperable data structures would facilitate integrated workflows that combine materials, testing and digital capabilities.
- **Facilitate networking, workshops and joint events**: Workshops, conferences and structured exchanges were seen as essential for helping infrastructures to explore collaboration opportunities. Replacing separate, siloed events (one for EDIHs, one for RIs, etc.) with a single large EU level conference gathering all communities can increase collaboration.

- **Build long-term collaboration visions and coordinated planning**: Beyond events, there is a need for long-term shared strategies and aligned funding to ensure that collaborations with digital initiatives is sustainable, rather than ad hoc or project-driven.

5.5. RI&TI collaboration with regulatory sandboxes

Regulatory sandboxes are controlled experimentation spaces that allow innovators to test new products, services, or business models in the real world under a regulator's oversight. Crucially, sandboxes can grant temporary regulatory flexibility, for example, waiving or relaxing certain rules, while still safeguarding core objectives like safety, consumer protection, and fairness[85]. The EC defines regulatory sandboxes as schemes for testing innovations in a controlled real-world environment with possible temporary loosening of applicable rules, so long as regulatory objectives are upheld[86]. Moreover, the New European Innovation Agenda adopted in July 2022 explicitly calls for "enabling deep tech innovation through experimentation spaces" as one of its five flagship initiatives[87].

To achieve this, the EC released a comprehensive guidance document on Regulatory Learning in the EU: Guidance on regulatory sandboxes, test beds, and living labs in the EU, with a focus on energy.[88] This guidance maps out available experimentation tools and showcases examples across Europe and beyond on how governments can "support and engage innovators in the regulatory process. The energy sector was chosen as achieving climate and sustainability goals often requires innovative technologies and business models (smart grids, energy storage, hydrogen, etc.) that current regulations did not anticipate. More specifically, the main areas in the energy sector where regulatory experimentation is necessary include:[89]

- **Energy communities**: support energy communities' formation, operation, and integration into the grid, including self-consumption and peer-to-peer trading for energy sharing.
- **Energy storage**: experiment with new business models and pricing structures that can support the deployment of storage technologies and use of storage systems as network assets.
- **Electric mobility**: Regulatory experimentation to manage the charging infrastructure, incentivise the adoption of electric vehicles, and address the challenges of grid integration (smart charging, V2G and G2V).
- **Design of tariffs**: TNUoS (Transmission Network of Use of System) and DUoS (Distribute use of System) tariffs that determine the types of expenditures prioritised (OPEX vs. CAPEX) for grids, including payback periods. Develop effective incentive-based targets and rewards to meet the challenges of the energy transition and the shift from central to distributed sources of energy.

Beyond energy, the EU has supported sandboxes across many domains as part of a broader move toward "agile" regulation. EU Member States and the Commission are actively looking at sandboxes in areas such as artificial intelligence, health (e.g. medical devices, prosthesis) and pharmaceuticals, transport/mobility, and AdMa, among others.

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[85] Retrieved from: https://wbc-rti.info/object/document/24368.html
[86] Retrieved from: https://wbc-rti.info/object/document/24368.html
[87] Retrieved from: https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda_en
[88] EC Staff Working Document. Regulatory learning in the EU Guidance on regulatory sandboxes, test beds, and living labs in the EU, with a focus section on energy Retrieved from: https://research-and-innovation.ec.europa.eu/system/files/2023-08/swd_2023_277_f1.pdf
[89] Regulatory sandboxes – Policy report drafted by WG5's regulatory sandboxes task force, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2833/676429

In 2023, the Council of the EU emphasised the value of sandboxes for AdMa. In its conclusions on the EU's new Advanced Materials strategy, the Council "highlighted the role of regulatory sandboxes and standards as enablers of innovation".[90] This underscores that at the highest policy levels, sandboxes are seen as a vital tool to boost cutting-edge innovation while ensuring it develops under regulatory oversight.

Following the stakeholder consultation (interviews, survey and insights collected in the validation workshop), **examples of RI&TI focused on AdMa collaborating with regulatory sandboxes were not observed.** Nevertheless, reducing regulatory barriers and administrative burdens associated with the production and use of AdMa, by streamlining regulatory and permitting procedures, is considered essential by both RI&TI operators and RI&TI users.

6. Guidance for the development of a single-entry catalogue

This section provides an overview of the guidance for setting up the single-entry catalogue. The guidance is structured in the following sections: type of information that should be included in the catalogue, suggested governance model of the catalogue, user friendly interface, incentives for RI&TIs to participate in the single-entry catalogue, activities and measures to achieve financial sustainability.

The single-entry catalogue has been proposed by the European Commission in the communication Advanced Materials for Industrial Leadership to provide guidance to companies on how to access existing Technology Infrastructures supported by the Commission and Member States, including also the services they provide[91]. Work on this catalogue continues in alignment with the broader 2025 Research and Technology Infrastructures (R&TIs) strategy. Currently, a Horizon Europe CSA call "Mapping and service finder for Technology Infrastructures (CSA)“ has also been launched.

Focus of the catalogue and information to be included in the single-entry catalogue

The catalogue should focus on listing Technology Infrastructures that provide services related to technology development, prototyping, testing, upscaling and validating. The ability to include information in the catalogue should be accessible to all European TIs. The catalogue should contain clear, standardised, and comprehensive descriptions of infrastructure capabilities and services. These include:

- **General information**, such as contact information, geographic location, etc.
- **Technical capabilities and services, equipment specifications, performance parameters, material or service domains, and TRL coverage**. In addition, information on **related competencies and expertise** offered by the RI&TIs is important, as SMEs also seek specialised knowledge and experience of the personnel operating the facilities. However, in this context, the inclusion of clear contact information is considered essential, particularly for SMEs, for whom highly technical descriptions alone may be of limited value without a designated contact point to contextualise and clarify available services.
- **Access conditions** (incl. training requirements and IPR conditions), **eligibility criteria and typical lead times should be included in the catalogue.** In terms of listing pricing models, several risks must be considered. Listing fixed prices may be challenging, as costs often depend on the specific scope and nature of the requested services. A more flexible

[90] Retrieved from: https://data.consilium.europa.eu/doc/document/ST-16183-2024-INIT/en/pdf
[91] Retrieved from: https://research-and-innovation.ec.europa.eu/document/download/0fcf06ea-c242-44a6-b2cb-daed39584996_en?filename=com_2024_98_1_en_act_part1.pdf

approaches therefore to pricing information should be pursued, **including indicative ranges or standard and specialised rates**.

- **Application examples, use cases and case studies** focused on the successful use of the facility.
- **Financial support available** (at regional, national and EU-level) **to access each infrastructure**. TI operators typically are aware of existing regional/national financial instruments supporting access to their facilities.

In general, decisions on the information to be included in the SEC should be guided by an understanding of user needs. The catalogue should primarily address the interests of potential users rather than those of other TIs.

Incentives for sharing information in the catalogue

The information points included in the catalogue will have to be shared and regularly updated/reviewed by RI&TIs providers. However, lessons learned from multiple infrastructure mapping exercises show that this is labour-intensive exercise. Therefore, incentives supporting TIs in uploading the information and regularly updating it will be critical. Based on the TI consultation, the most effective non-financial incentives include:

- **Information in the single-entry catalogue should be communicated to TI ecosystem as an opportunity to increase visibility at the EU level**. Also, high participation of large TI operators (e.g. leading of RTOs and Technical Universities) would create “fear of missing out” in the ecosystem and would further increase participation. Therefore, before launching the single-entry catalogue, ensuring a “buy-in” from a critical mass of infrastructure providers would be critical.
- Another incentive for TI participation focuses on a **simple process to provide and update the information shared in the catalogue**. Therefore, the study team recommends leveraging already existing mappings/inventories and information provided on the infrastructure websites to pre-fill the information points per infrastructure.
- **Eligibility for funding instruments connected to the catalogue**: TIs included in the catalogue could benefit from funding mechanisms supporting beneficiaries in accessing TI services. Similar initiatives include the EIC service provider catalogue and ACCESS+ programme. More specifically, EIC ACCESS+ aims to enable EIC Awardees, and Seal of Excellence holders to access specialised services, including access to TIs from the EIC Service Catalogue, by offering **financial support of up to €60k per beneficiary**. The partial funding of the selected services will enable European deep-tech innovators to access TIs, among other services.

Moreover, it will be important to communicate the added value of the single-entry catalogue to TIs to further incentivise participation. Examples include dissemination of success cases where the catalogue contributed to attracting new users, forming new collaboration between TIs (e.g. leveraging the catalogue for forming consortia for competitive public funding calls or establishing a new staff mobility programme).

User-friendly interface

The single-entry catalogue should be a user-friendly, web-based platform with intuitive navigation and filtering capabilities. To ensure this, key technical features should include:

User perspective (e.g. SMEs):

- **Advanced search and filter functions** (e.g. by location, services offered, material types, TRL, use cases, geography).

- **Integration of AI to facilitate the user experience while navigating the catalogue**. An AI agent, for example, could enable faster search of facilities by enabling users to type their needs and recommending the most relevant facilities.
- **Interactive elements**, such as direct contact forms, maps, and possibly booking or pricing quotation requests, should be included as well.

TI operator perspective (e.g. RTO):

- TI operators should have the **possibility to log into the single-entry catalogue** and update available information.

Governance model for the catalogue

The catalogue **should be operated by a neutral, centralised and independent governance body.** This is key as an impartial entity, independent from individual infrastructures, would ensure fairness and prevent conflicts of interest. Therefore, the catalogue should be operated centrally by the European Commission (e.g. similarly as EIC access to services platform), or an independent operator can be selected via public procurement or a Horizon Europe call for proposals.

The operator of the single-entry catalogue should be supported by a multi-stakeholder advisory board involving RI&TIs, industry associations, Member States, and EU bodies. This body can guide the scope, define data standards, champion the mapping to peers and suggest measures to update the catalogue to address the evolving user needs. In addition, **local innovation nodes,** such as RTOs, Enterprise Europe Network (EEN) branches, accelerators and EDIHs, should have a central role in leveraging the catalogue to suggest available TIs to industrial users.

Financial sustainability

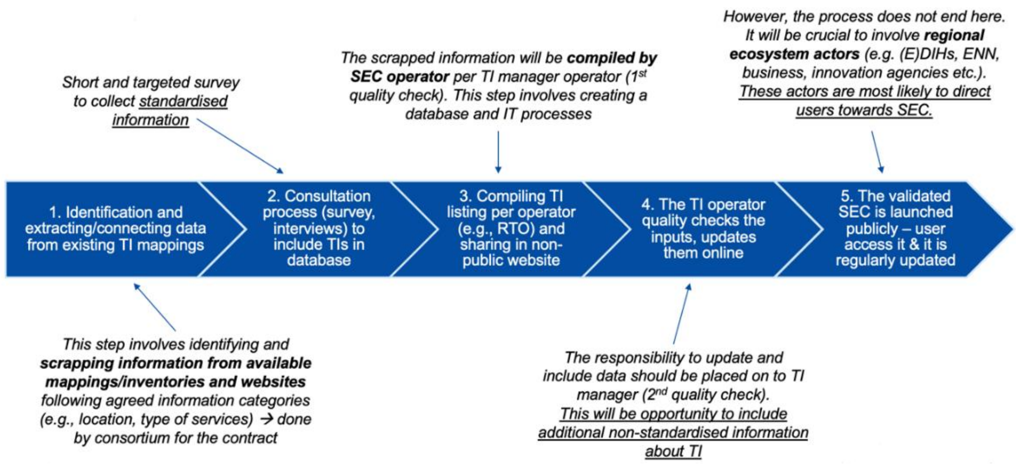
Consulted stakeholders have highlighted that achieving financial sustainability from the launch of the catalogue would be challenging. Therefore, at first, a **mixed funding model combining EU support and private funding should be established**. This model should incorporate a gradual public funding phase-out process. The private funding element could be covered through the following measures:

- Commission fee based on the type of services provided and quoted to industrial users that have access the services using the catalogue.
- Fixed subscription-based fee where participation in the single-entry catalogue would be open to subscribed organisations.

Process of setting up and managing the single-entry catalogue

The figure below provides an overview of a proposed process to set up the single-entry catalogue.

Figure 16 Proposed process to set up and run the single-entry catalogue.



Source: Technopolis Group.

Additional points

It is important to implement robust security, competition and compliance safeguards given concerns about sensitive infrastructure data.

7. International benchmark

The table below provides a benchmarking of EU's AdMa RI&TI landscape with Japanese, UK and US landscapes.

Table 4 International benchmark

Dimension	EU	US	UK	Japan
Mappings / Inventories	No single EU-level mapping. Inventories are fragmented across initiatives (e.g. MERIL, EPPN, OITBs). National and organisation level mappings are predominant. Coordination	Multiple parallel mappings by federal agencies (e.g. DOE Lab Partnering Service, NSF Major Research Facilities catalogue, NNI Shared Infrastructure Programme, Manufacturing USA network).	National InfraPortal (830+ R&I infrastructures) led by UKRI complemented by Catapult Network maps and Innovate UK's Cluster and Metamaterials maps are the main inventories.	ARIM (Advanced Research Infrastructure for Materials and Nanotechnology) – single, unified national mapping of more than 7,400 facilities (mainly at the level of equipment) integrated with digital data platform (ARIM-mxd) and

Dimension	EU	US	UK	Japan
	varies from organisations to project-based initiatives or dedicated governance structures (e.g. ESFRI mapping)	No unified national platform, but overall good agency visibility of existing capabilities.		NIMS Data Ecosystem (DICE).
AdMa RI&TIs	~ 2,900 AdMa RI&TIs identified in EU. Concentration in Germany, France, Spain and Italy. Limited availability of RI&TIs in modest innovator regions.	~800 AdMa RI&TIs identified. Concentration in Midwest and coastal clusters.	~800 AdMa RI&TIs identified. Strong link / concentration near industrial sectors (e.g. Manchester, London area).	~300 AdMa RI&TIs identified. Clustering around areas close to Tokyo, Osaka, and Kyushu.
Sectors of application	Electronics (42%), Energy (30%), Medical devices (10%), Mobility (13%) Construction (4%)	Electronics (38%), Energy (33%), Medical devices (14%), Mobility (12%) Construction (4%)	Electronics (34%), Energy (34%), Medical devices (15%), Mobility (13%) Construction (4%)	Electronics (46%), Energy (43%), Medical devices (4%), Mobility (5%) Construction (2%)
Accessibility	Mixed approach depending on the business model of RI&TI. Challenges related to SME, start-up accessibility. Barriers include cost and	Mixed approach depending on the business model of RI&TI. For example, dual open/proprietary access via DOE GOCO model, tiered membership via Manufacturing USA.	Mixed approach depending on the business model of RI&TI. Tiered access models (Royce Institute open-access, Catapult tiered membership). SME face access barriers related to costs and proximity of infrastructures.	Mixed approach depending on the business model of RI&TI. For example, national open-access system (ARIM, Nanotechnology Platform). Regional access gaps persist outside major hubs.

Dimension	EU	US	UK	Japan
	administrative complexity.	Challenges include access speed and data-sharing.		
Funding and sustainability of AdMa RI&TIs	Mix of EU (Horizon, Digital Europe, ERDF) and national funds; CAPEX funded better than OPEX; need for sustainable governance and financing.	Multi-agency federal funding and private-public partnership-based funding. OPEX sustainability challenges and challenges for CAPEX mainly due to reliance on cyclical base funding.	UKRI core funding and industrial cost-sharing. Post-Brexit loss of EU Structural Funds has increased regional imbalance in terms of available funding for RI&TIs.	Long-term sustainability through national endowment (10 trillion JPY fund) and programmatic funding (SIP, NEDO, JST); stable multi-year planning.
Selected challenges	Fragmentation, data heterogeneity, limited SME visibility, uneven regional distribution.	Coordination across agencies, mid-scale infrastructure gaps, administrative delays, data-sharing barriers.	Funding continuity, regional access disparities, SME affordability, limited TRL 6–9 coverage, and certification/testing infrastructure gaps.	Regional concentration, SME underrepresentation, rigid contracting/IP rules, aging workforce, and limited start-up participation.

Source: Technopolis Group

The table below provides an overview of the good practices identified in Japan, US and UK. The international country reports are provided in a separate annex of the study.

Country	List of best practices
Japan	Japan's national mapping of Research and Technology Infrastructures focused on AdMa is carried out by on the Advanced Research Infrastructure for Materials and Nanotechnology (ARIM), the programme and discovery portal is operated by NIMS. The website functions as the public source for shared clean rooms, characterisation centres, pilot and scale-up lines and related data services. An important extension took place with the introduction of **ARIM-mxd (Materials Data Platform).** This nation-wide platform tightly integrates data generated across a network of 40 shared-use experimental infrastructures and 9 major Japanese supercomputers via SINET providing a unified digital ecosystem for materials science research.

	A notable good practice is the Japanese strong emphasis on collaboration between the industry and academia. Large corporations like Mitsubishi and LG maintain dedicated spaces within NIMS and joint laboratories demonstrate thriving industrial partnerships[92] with foreign companies and research organisations like LINK (collaboration between NIMS, CNRS and Saint-Gobain)[93]. These models facilitate direct access to cutting-edge facilities and foster knowledge transfer between public research and private industry. NIMS further supports SMEs and start-ups through organising exhibitions and networking events, where they can showcase their innovation and connect with prospective partners[94]. SMEs receive further technical assistance by entities such as AIST to prepare funding proposals, reducing entry barriers for companies with limited resources.[95]
US	US AdMa infrastructures operate mainly through public–private partnership models designed to combine federal investment with private co-funding. This model enables to achieve strong alignment between the AdMa RI&TI service offerings and with market. For example, manufacturing USA institutes follow a common model in which the federal government provides funding for five to seven years, matched by industry contributions. Another good practice example is tiered service pricing models offered by RI&TIs operators. The **California NanoSystems Institute (CNSI)** at UCLA, for instance, offers a three-tier pricing system: University of California researchers pay cost-recovery rates, external academics and non-profits pay cost plus overhead, and industry users pay a market rate. CNSI provides both open-access use and staff-delivered services, with staff often developing bespoke instruments or methods when commercial solutions are unavailable. **To support collaboration between AdMa RI&TIs and industry, US has launched the Critical Materials Collaborative (CMC).** The objective of the initiative is to de-risk innovation and mature technology development by creating partnerships between research institutes (operators of TIs) with industry. **One of the focus of the partnership is to prototype and pilot technologies and processes proven at the bench scale to accelerate innovative solutions that address critical materials challenges in high-impact areas:** • Use of magnets with reduced critical materials content • Improved unit operations of processing and manufacturing of critical materials: Projects will make improvements to unit operations and/or processes to separate, refine/process critical materials for clean energy technologies that rely on critical materials. • Critical material recovery from scrap and Post-Consumer Products: Selectees will develop and validate approaches to recycle or recover critical materials from post-consumer products, including design for recycling and reuse and de-risking critical material recovery from waste and manufacturing scrap.

[92] Retrieved from: https://www.nims.go.jp/eng/business/collaboration/index.html
[93] Retrieved from: https://tokyo.office.cnrs.fr/cooperation-japan/link/
[94] Retrieved from: https://www.nims.go.jp/eng/events/r6nk52000000cwei.html
[95] Input from an interview with a RI&TI operator-representative

	• Reduced critical material demand: Selectees will develop and validate materials, technologies, or processes that reduce or eliminate the use of critical materials for energy technologies. One example is the “Accelerate Validation of a Domestic, Sustainable Alternative for Battery Grade Graphite in Lithium-Ion Batteries” project implemented by Pacific Industrial Development Corporation, XALT Energy, Applied Catalyst, Argonne National Laboratory. The proposed work aims to bridge the current capability gap with the eCOphite technology by demonstrating the performance of LIBs with partial or full replacement of graphite at commercially relevant scales of battery formats and sizes.
UK	In 2020, UKRI launched **InfraPortal**, an online catalogue of UK R&I infrastructures. The portal was initially populated with information on over 500 infrastructures, but is regularly updated by operators themselves, and in 2025 listed over 830 entries. Users can search by discipline, sector, or region, and while the portal does not distinguish between research and innovation infrastructures, it provides the most up-to-date overview of significant facilities accessible in the UK.[96] In 2023, the Department for Science, Innovation and Technology published the **Innovation Clusters Map**, designed to identify concentrations of research and industrial activity across the UK, including clusters focused on AdMa.[97] The objective of such map is to direct public support and attract private investment by making visible the regional distribution of capabilities. Complementing this, Innovate UK KTN is developing a **Metamaterials Landscape Map**, following the recognition of metamaterials as an Advanced Material opportunity in the UK Innovation Strategy. The tool aims to provide insight into universities, companies and research centres working in the field. It is searchable by sector, expertise and capabilities.[98] To strengthen financial sustainability, some infrastructure providers are creating spin-offs or investing in start-ups. Centre for Process Innovation’s venture capital arm, CPI Enterprises, invests in early-stage deep-tech firms, often at pre-seed to series A stages, with the goal of helping technologies scale. This approach helps de-risk innovation for other investors and enable CPI to generate returns from e.g. exit of the start-up. Collaboration within the UK’s AdMa RI&TIs providers is coordinated by the Royce Institute, which acts as the national focal point for materials research, coordinating university and laboratory partners through shared equipment registries and cross-institutional access systems. This model has significantly reduced duplication of assets and encouraged resource sharing across sites.[99] The Catapult Network provides the main translational interface, linking academic discovery with industrial

[96] UKRI, Infraportal. Retrieved from: https://www.infraportal.org.uk/Search

[97] Department for Science, Innovation & Technology, Innovation Clusters Map. Retrieved from: https://www.innovationclusters.dsit.gov.uk/

[98] UK Metamaterials Network, KTN Landscape Map. Retrieved from: https://metamaterials.network/map/

[99] Input from an interview with a RI&TI operator-representative

	demonstration through centres such as the National Composites Centre, the Manufacturing Technology Centre and the Centre for Process Innovation. Finally, to simplify user access, the Centre of Expertise in Advanced Materials and Sustainability (CEAMS) acts as a **single access point** for companies, directing projects to the most relevant partners across Catapult centres, the Royce Institute, and universities. CEAMS adds a further layer of coordination by integrating access to these assets through a single-entry point for businesses, enabling multidisciplinary projects that combine materials science, metrology and manufacturing expertise.

Source: Technopolis Group

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Appendix A Taxonomy of RI&TIs and Advanced Materials

The table below provides an overview of the keywords used to capture Research and Technology Infrastructures.

List of keywords		
• Research Infrastructures • Technology Infrastructures • Research and Technology Infrastructures • Pilot lines / plants • Test beds • Test rooms • Testing facilities • Open Innovation Test Beds • Verification lines	• Scientific infrastructures • Living labs • Regulatory sandboxes • Testing and experimentation facilities • Innovation infrastructures • Technology platforms • Technology centres • Colabs • Clean rooms • Innovation labs	• Field labs • Pilot demonstrators / demonstrator sites • Demonstration environments • Demonstration sites / facilities • Facilities, equipment, capabilities and resources required to develop, test, upscale and validate technology • Experimentation facilities • Testing, experimentation hubs • Pilot centres • Prototyping centres/ facilities/ lines/ labs

Note: Plural forms, spelling variations and abbreviations will also be included as keywords.

The table below includes the taxonomy shared by the European Commission and our additional edits.

Sectors of applications

Category	Keywords
Energy	
Energy conversion and generation	• Advanced Materials for improved durability and operational performance in energy conversion and generation • Photocatalytic conversion • Artificial photosynthesis • Energy to chemicals • Photo-electrochemistry

	• Composites: lightweight, permanent magnets, critical raw materials, rare earth elements • Coating and impermeability • Photovoltaics, Perovskite solar cells, tandem PV • Heat conversion • CRM-free/lean/bio and efficient catalyst for energy conversion and CO_2 reduction • High-performance catalysts (including biological and biocompatible materials) for converting CO_2 into fuels, chemicals (e.g. Methanol) at low temperatures and low pressure • Selective catalysts for ammonia synthesis from N_2 and H_2, e.g. for low-temperature/pressure Haber-Bosch thermochemical conversion and Li-mediated electrochemical N_2 reduction • Catalysts for bioconversion of atmospheric N_2 into ammonia • Wind turbine materials (carbon fiber blades, permanent magnets for generators using rare-earth elements) to increase durability and monitoring of transmission components, coatings • Advanced Materials for improving conversion efficiency in different renewable energy sources (RES) (e.g. photovoltaics panels, wind turbines or heat pumps) • Advanced Materials to improve the durability of devices to convert renewable energy sources • Advanced Materials for coating and impermeability • Advanced Materials for improving environmental operating conditions (e.g. corrosion resistance) • Advanced Materials for new nuclear reactor design that operate at higher temperatures for increased efficiency • Advanced Materials with resistance to the damaging effects of neutrons and other radiation within the reactor core • Advanced Materials with the ability to withstand chemical environment within the nuclear reactor • Advanced Materials for fuel cladding (Cr-coated Zircaloy, Ferritic Fe–Cr–Al alloys, SiC/SiC ceramic composites).
Energy distribution and the transmission	• Advanced Materials to increase the efficiency and capacity, reliability and durability of the energy distribution and transmission grid • High performance coatings protecting infrastructures against corrosion, friction, icing.
Energy storage systems	• Advanced circular and more sustainable materials for energy storage technologies • Electrolysis • Power to chemicals • Power to energy • Materials for energy harvesting and storage capabilities (solid-state batteries, Li–S and Li–air batteries, Na batteries, K batteries, redox flow batteries, supercapacitors, hydrogen storage materials, fuel cell membranes)

	• Printed electronics • Piezoelectric • Electrochemical technologies (e.g. batteries and supercapacitors) • Thermal and thermochemical technologies (e.g. phase change materials) • Supercapacitors • Innovative concepts, designs & components for efficient H2 and thermal energy storage (e.g. metal hydrides and metallic IAMs (Innovative Advanced Materials), metal foams.
Renewable fuels	• Advanced Materials to produce sustainable fuels, like renewable fuels of non-biological origin and synthetised fuels • Catalyst; (specifically, catalysts that are sufficiently active, stable, and low in cost to produce renewable fuels or chemicals in large quantities and at low cost) • Photocatalysis for solar fuels, artificial photosynthesis • High-conductivity and durable membranes for efficient H2 production and conversion, e-fuel and e-chemical production (including enhanced ionomers).
Mobility	
Energy-storage and alternative fuels for different means of transport	• Advanced batteries (e.g. solid-state) characterised by higher efficiency, reduced environmental footprint in their production, reduced use and sustainable substitution of critical raw materials, improved safety profile, better durability, performance, higher energy density, and greater recyclability • Fuel cells systems for hydrogen, ammonia and/or methanol with much higher efficiency and focus on waste heat recovery solutions; electrolysers; catalysts • Silicon chemistries • High energy density materials • Electrification (high-energy-density batteries, Si-anode and solid-state cells, ultracapacitors) • Alternative fuels (bioethanol, biodiesel. hydrogen fuel cells, ammonia/methanol-ready materials, cryogenic tank materials) • Materials for H2 storage • CRM-free magnets • E-fuels.
Advanced high-performance materials for lightweight, able to perform in harsh environments, highly reliable and durable transport applications	• Lightweighting structures (advanced designs, carbon fiber composites, high-strength aluminium and magnesium alloys and coatings to enhance lifetime, thermoplastic composites for automotive, easy to recycle vitrimers) • Advanced - lighter - materials that combine reduced energy consumption with increased safety • High-strength steel, additive manufacturing to improve materials efficiency

	• Advanced composite materials and structures for vehicles, aerostructures and engine components, including high-performance thermoplastics, adaptive systems, multifunctional requirements (e.g. soldering or processes to reliably join different materials).
Increased protection, resilience and durability for transport means and infrastructures	• Monitor, safety, stability and operation of bridges and transport infrastructures. • Advanced Materials for increasing coatings and paints durability as well as decreasing fuel consumption • Combining extrusion-based additive technologies and automated fibre placement • Joining technologies, surface treatments and automated quality inspection/control for large primary aerostructures and engine components • Materials to improve tribological properties (increasing the durability of components) • Resilient coatings (anti-corrosion, self-healing paints) for durability • Safety enhancements (impact and wear resistant composites, fire-retardant materials, improved crash absorption foams) • Fire resistant, self-monitoring, self-repair materials.
Increasing circularity and addressing environmental performance of materials	• Recyclable and/or biodegradable composites, batteries and electronics uses in all transport modes • New materials that further reduce the environmental footprint and increase the resilience of transport infrastructure (lower lifecycle impact, circular use, longer lasting/more resistant materials for roads/rail tracks, less impact on biodiversity; tyres and breaks with low particulate matter emission) • Cost-efficient maintenance and repair of advanced composites, superalloys, coatings, hybrid and adaptive structures for transport applications.
Construction	
Improving energy efficiency of buildings	• Advanced Materials for temperature control, heat transfer, cooling, thermoelectricity • Composite foams • Energy-efficient building materials (advanced insulation like aerogels and vacuum insulated panels, phase-change materials for thermal storage, smart glass/windows) • Material efficiency for buildings • Sustainable concrete (low-CO_2 cement, geopolymer concrete, self-healing concrete) • High-strength structural composites (fiber-reinforced concrete, basalt fiber rebar); rebuilt, repair technologies • Materials to improve circularity and address environmental performance. For example: novel bio-based coatings, paint formulations, wood-based insulation, adhesives and composite materials in buildings, and addressing the global

	warming potential of such materials linked to buildings and their deconstruction.
Making buildings structures more robust and longer lasting and better monitoring of structural integrity	• Preventive conservation, monitoring sensors • Durability & monitoring (corrosion-resistant coatings on rebar, embedded sensors for structural health monitoring and monitor corrosion resistance, moisture-responsive ventilation materials) of materials • Bio-based materials (engineered wood, bamboo composites, mycelium insulation) • Materials for odour or noise reduction • Composite materials including graphene-enhanced concrete, lightweight materials, new materials for 3D printing, Additive manufacturing, materials for pre-fabrication and modular construction, materials, and self-monitoring, self-healing or self-protecting materials.
Greater wellbeing in buildings	• Materials for increased comfort, noise reduction • Materials for lighting, dynamic optically transparent and glazing technologies, transparent oxide-based electronics, electrochromic, thermochromic, gasochromic, photochromic materials, and anti-soiling, anti-ice, anti-slip, anti-corrosion or superhydrophobic treatments.
Materials to improve circularity and address environmental performance	• Novel bio-based coatings, paint formulations, wood-based insulation, adhesives and composite materials in buildings, and addressing the global warming potential of such materials linked to buildings and their deconstruction • Advanced Materials for building rebuilt, repair.
Electronics	
Better performance, reduced energy consumption and new functionalities of electronic components	• Organic and large area electronics (OLAE) • 5G & 6G networks (signal transmission and thermal management for the next generations of 5G & 6G networks and beyond) • Silicon photonics • Sensors • Spintronics • Next-generation semiconductors (GaN, Ga_2O_3, 2D channel materials for transistors, carbon nanotube electronics) • Materials for energy harvesting • Flexible and printed electronics (organic photovoltaics, printed sensors, conductive inks) • Photonics & optoelectronics (quantum dot displays, OLED and MicroLED materials, photonic crystals, optical fiber materials) • Advanced memory and logic (phase-change memory materials, memristive oxides) • Quantum computing materials (Josephson junction superconductors, topological qubits materials)

	• Monolithic integration with existing semiconductor technology • Packaging, coating for increased durability • Materials for thermal management • Advanced Materials for better performance, including specific characteristics to perform in harsh environments, reduced energy consumption and new functionalities of electronic components, including sensors, novel computing and memory concepts, power electronics, communication.
Advanced Materials for new chip	• Advanced Materials for new chip production and packaging technologies, including wafers and substrates beyond silicon for enhanced efficiency (for applications in different areas like energy, power and communication), enhanced durability, sustainability and circularity, and reduced dependency on CRM.
Digitalisation	
Digitalisation of Advanced Materials	• Advanced Materials Modelling, simulation, multiscale models • Workflows, software solutions, experimental data digitalisation, connecting processing and testing machines with computer, data documentation, ontology, interoperability, digital marketplace for Advanced Materials • Advanced Materials discovery or optimisation via artificial intelligence and data-driven design – e.g. computationally predicted alloys (high-entropy alloys designed by machine learning algorithms), inverse-designed photonic crystals and metamaterials (AI-optimised structures for target optical properties), catalysts discovered through automated screening, polymer formulations optimised by evolutionary algorithms. • Materials informatics approaches (large-scale materials databases, neural-network models guiding new material compositions) accelerating R&D • Digital twins for Advanced Materials.
SSbD	
Assessment methods and tools	• Risk assessment, hazard assessment, eco-toxicology, characterisation, predictive toxicology, exposure, migration, test guidelines, integrated approaches. • Materials performance, environmental, economic and social sustainability LCA, LCC, S-LCA.
Alternatives to hazardous substances (e.g. PFAS, CrVI, Cd):	• Anticorrosion, antifouling, antiwear, antimicrobial, nano-coatings, polymers, surface treatments (e.g. Coatings, texturing, plasma/gas treatments, PVD, solgel, plasma electrooxidation)

Manufacturing	
Manufacturing of Advanced Materials	• Additive manufacturing, multiphase processes • Manufacturing biobased materials, functional surfaces, • Inkjet printing, bio-printing, injectable biomaterials • Zero defect manufacturing • Mass customisation
Characterisation	
Material characterisation	• Non-destructive testing, x-ray, diffraction, spectroscopy, materials data, real time characterisation, real time imaging, modelling, particle release characterisation • Materials database • Material standardisation • Validation of material characteristics • Materials value chain traceability
Circularity	
Recycling	• Catalysts for chemical recycling and upcycling • Procedures for products and components' end of use/life to enable refurbishing, de-manufacturing, dismantling, disassembly, materials sorting and recycling • Circular IAMs based on new environmentally friendly polymer recycling mechanisms; recycling processes with lower CO2 footprints based on novel depolymerisation technologies (chemical or biotechnologies such as enzymes or bacteria engineering) and monomer purification/separation technologies solvent assisted separation of polymers. • Advanced Materials based on (designed for) recyclable polymers/polymeric composites
Waste treatment	• Advanced membranes • Advanced sorbent materials (activated carbons, MOFs, functional polymers, resins, etc.) • Advanced Materials for water treatment • Self-cleaning membranes, ultrafiltration
Health (Medical devices)	
Medical devices	• Biocompatible materials • Bioinformatics (modelling, simulation) • Nanocoating (antimicrobial, antiviral, antifungal) • Controllable degradability • Antimicrobial material (graphene) • Biomaterials for implants (titanium alloys with porous coatings, bioactive ceramics like hydroxyapatite coatings) • Tissue engineering scaffolds (collagen and hydrogel matrices, 3D-printable biodegradable polymers)

	• Drug delivery nanomaterials (polymeric nanoparticles, liposomes, dendrimers, stimuli-responsive hydrogels) • Diagnostic and wearable materials (flexible bioelectronics, implantable sensors, lab-on-chip substrates) • Antimicrobial coatings (nano-silver, copper coatings for medical devices) • Advanced Materials improving the quality, efficacy, and safety of medical technologies • Advanced Materials enabling personalised medicine, facilitating tailored diagnoses and treatments that cater to individual patient needs. • Medical devices for more effective and minimally invasive medical procedures, for reduced surgical interventions and reduced healthcare costs: - (Multi-)functional Advanced Materials and coatings which are, depending on the intended use, biocompatible, bioactive, biodegradable, antimicrobial, restorative, resorbable, reversible, and/or durable, that may seamlessly integrate with biological tissues, ensuring safety and minimising adverse reactions and additional healthcare procedures. - Smart, adaptative, bioactive, and stimuli-responsive materials, including biologically inspired materials and catheters, for medical devices that are tailored to individual patient needs and body biomechanics, reducing the need for device replacements and additional surgical interventions. - Advanced bioadhesives, bioinks and coatings for in vivo minimally invasive surgical robotics that ensure greater precision, improved patient outcomes, faster tissue regeneration and shorter recovery times. - Materials that contribute to circular economy and secondary materials for single-use medical devices in pre-analytical and life-science workflows, that contribute to reducing healthcare wastage and undesirable atmospheric emissions. • Medical devices to enhance therapeutic efficacy and patient comfort: - Advanced Materials with demonstrated biocompatibility and sustainability for implants that modulate biological systems therapeutically, improving wound healing, and modulating immune response - Advanced Materials, including engineered nanostructures and biomaterials like vesicles and immune therapies (excluding pharmaceuticals), that ensure the precise and targeted delivery of therapeutic agents to defined cells or tissues, or that have a therapeutic effect through drug-free physical or chemical modes of action. • Wearable and Implantable medical devices enhancing patient autonomy: - Advanced Materials (e.g. flexible, stretchable, bioelectronic, electroconductive) for implantable devices, sensors and soft robotics to empower patients through

	self-management of health conditions, offering continuous real-time monitoring of vital signs or biochemical markers or promoting tissue repair, to enhance patient autonomy, facilitate early detection of disease, and provide preventive care or early intervention and to promote personalised medicine. - Materials that provide sustainable, uninterrupted and health-compatible energy supply for wearable medical devices and prolong their working lifetime, harvesting energy from the human body and functional environment • Medical devices for advanced diagnostics with improved sensitivity and specificity: - Advanced Materials, including nanomaterials, for efficient, multiplex, and ultrasensitive sensors to integrate in vitro diagnostic systems, point of care devices (including paper-based tests), and in vivo diagnostic systems, such as catheters, transdermal patches or ingestible pills, to detect biomarkers at molecular level, enabling early diagnosis (especially in primary care), precise monitoring, and personalised targeted treatment selection. - Imaging Probes and contrast agents that accumulate in target tissues, enhancing imaging accuracy and enabling the early detection of disease. - Theragnostic materials for combined diagnostic and therapeutic effects.
Organ replacement, artificial tissues, and enhanced regenerative medicine & Organ-on-a-Chip Systems and tissue engineering for accurate tissue and disease modelling and reduced animal testing	• Organ replacement, artificial tissues, and enhanced regenerative medicine - Advanced Materials to enable the fabrication of functional tissues and organs to address organ failure to reduce dependence on organ donors, replacement of bioprosthetic devices and animal tissues, for restoration of normal function (including biomechanics), and for improved treatment outcomes and improved patient lifespans - Advanced Materials including bioinks for 3D/4D bioprinting, composites, carriers, and scaffolds offering biocompatibility, as well as enhanced mechanical and biochemical properties, for more effective regenerative medicine, tissue regeneration, and other Advanced Therapy-related interventions as well as potential organ transplantation. - Bioactive materials incorporating living cells and/or microorganisms (engineered living materials, ELMs), enabling dynamic and responsive functionalities, such as in-situ production of therapeutics or self-regeneration. • Organ-on-a-Chip Systems and tissue engineering for accurate tissue and disease modelling and reduced animal testing: • Advanced Materials to create complex, dynamic and biocompatible high-throughput systems (eventually incorporating sensing and actuation capabilities) that mimic human tissues or organs in architecture and function, thus

	improving the accuracy and speed of drug efficacy and safety testing, and reducing animal experimentation. • Digital tools (AI-driven and digital twin technologies) to combine material-related and patient-specific data to create models for personalised and predictive medicine.
Chemicals production	
Advanced Materials for chemical production	• Catalytic materials for hydrocarbons transformation; catalytic reactors • Catalytic materials to reduce exhaust emissions
Advanced Materials that have a dual-use application	
Dual-use application of Advanced Materials	• All keywords above (with dual application purpose) • Optical fibres • Conducting wires • Electro-active polymers • Electroactive ceramics and shape memory alloys as either sensing elements or actuators in "smart/functional" • Structural materials • Application of embedded silicon micro-sensors for in-service in-situ monitoring of composite structures • Biomimetic materials which may have structural applications in defence equipment • Morphing materials for structural uses • Graphene photodetectors • Thermal materials for space applications • High-performance materials engineered for soldier protective equipment • High-performance low-sensitivity and REACH-compliant energetic materials • Advanced Materials, structures for Protection Against Military Threats • Advanced Materials for camouflage • Surface engineering for maximum lifetime and/or hostile environments • Advanced and smart textiles for soldier systems and platforms.

Note: Plural forms, spelling variations and abbreviations will also be included as keywords.

Material functionalities

The table in the subsection include additional keywords related to material functionalities that were used for web-crawling analysis.

Material functionalities
• Electronic functionalities

• Optical functionalities
• Mechanical and structural functionalities
• Wear and corrosion resistance
• Friction properties
• Magnetic functionalities
• Thermal and thermo-electric functionalities
• Chemical functionalities
• Biological functionalities
• Conductive functionalities
• Smart and multifunctional materials (incl. phase change, shape memory, self-heating, self-manufacturing) tuneable materials
• High performance materials (strong, light weight, resistant)
• Recyclability

Note: Plural forms, spelling variations and abbreviations will also be included as keywords.

Advanced Materials categories

The table in the subsection include additional keywords related to Advanced Material categories that were used for web-crawling analysis.

Categories of Advanced Materials
• Metals
• Ceramics
• Polymers
• Semiconductors
• Biomaterials
• Nanomaterials

• Composites and hybrid materials
• Smart materials

Source: Chapter 2. Materials: types and general classifications in Saleh, T. A. (2021). Polymer Hybrid Materials and Nanocomposites: Fundamentals and Applications. William Andrew.

Note: Plural forms, spelling variations and abbreviations will also be included as keywords.

Appendix B Methodological note

B.1 Developing and running AI-based model to identify AdMa RI&TI operators & their RI&TIs through web crawling in EU-27, Japan, UK & US

The study team has **developed a model to identify the research organisations providing RI&TIs in the field of Advanced Materials.** The model is based on the taxonomy developed during the inception phase. Study's data team applied its AI technology that understands web content and produce a dataset of rich textual data from reading millions of EU organisation websites and other sources like news, social media, and sector-specific sources. The model crawled university websites and official government sources, whenever possible, to build an expanded database of RI&TIs operators in AdMa. The web crawl focused on the public web and ran across the various EU countries, the US, UK and Japan.

To identify the RI&TIs the study team has enhanced AI-based web-crawling model using a taxonomy of RIs and TIs. This taxonomy was translated and refined for each country, reflecting national relevance and usage of terms. The attributes collected include:

- Parent organisation
- Name of the infrastructure
- Abbreviation of infrastructure
- Description of infrastructure (all information available on the website)
- Country
- Address
- Sector of application
- Sector of application - associated keywords based on the taxonomy
- Material functionalities
- Material functionalities - associated keyword based on the taxonomy
- Material categories
- Material categories - associated keywords based on the taxonomy
- Contact person
- Email
- Website

B.2 Identifying the potential RI&TI users

The potential RI&TI users were identified based on patent and start-up data.

Patent data are a widely used measure for tracking technological development activities. It is important to acknowledge that there is a rather fundamental difference between technology generating companies and those that primarily use AdMa. For the former, a patent analysis is essential and useful. These companies are likely to use the R&D services offered by RI&TIs. For the latter, e.g. companies that use advanced materials in retail, tourism sectors, patenting data is less important. These companies are less likely to also use the R&D offered by RI&TIs. **The patent analysis was carried out using a combination of PATSTAT (online) and Orbis IP.**

To identify the patents in the field of AdMa the study team has leveraged the taxonomy of AdMa, and taxonomy based on an International Patent Classification (IPC) codes. The Orbis IP database has enabled the collection of additional metadata per company namely standardised financial information, including information on turnover, number of employees, R&D expenditures (where available), but also other information such as patent portfolio, patent valuation (calculated using a 'market Indicator valuation methodology' by Moody's), patents sold/acquired, geographic information at NUTS level among others.

The process in brief entailed the following steps: 1) validation of the taxonomy in terms of IPC codes; 2) extraction of the patents from PATSTAT and Orbis IP; 3) processing of applicant and inventor information to infer company names; 4) enrichment of the database of companies with financial, geographic and patent metadata from Orbis.

Technology start-ups represent key building blocks in the transition towards a more digital, green and resilient economic model. Entrepreneurial activity helps accelerate the diffusion of AdMa and start-ups that develop AdMa are relevant indicators for identifying users of RI&TIs. In this study, start-ups are defined as young, innovative, growth–oriented businesses in search of a sustainable and scalable business model. For the purposes of identifying AdMa RI&TI users, start-ups have been defined as founded after 2015.

To analyse technology start-ups the study team relied on **Crunchbase data**. Crunchbase is a widely trusted source of primary data on venture capital and private equity innovative companies. It is a provider of innovative, investment-backed technology active companies in the EU and competing economies such as the US. According to Crunchbase, the total number of organisations included in the database in July 2022 includes around 376 000 companies from the European Union and 8 400 000 from the US. Crunchbase information includes investments and funding information, founding members and individuals in leadership positions, mergers and acquisitions, news, and industry trends. Originally built to track start-ups, the Crunchbase website contains information on public and private companies on a global scale.

To identify the relevant start-ups focused on AdMa the study team relied on the taxonomy of AdMa. Relevant additional metadata derived from the Crunchbase database include total funding amount, funding rounds (type, date, amount, investors), geographic information at nomenclature of territorial units for statistics (NUTS) level among others.

The process entailed the following steps: 1) validation of the taxonomy of the AI-driven approach to identify start-ups in AdMa. This was done based on performance indicators in line with the EU AI Act and UNESCO recommendation on Ethics of AI, which will entail a proportionate, transparent and explainable approach to AI; 2) extraction of the starts ups; 3) enrichment of the database of companies with data on private and public funding raised and geographic information.

Appendix C List of AdMa RI&TI mappings

The table below provides a list of identified AdMa RI&TI mappings.

Name of mapping	Description	Enables the identification of AdMa RI&TI
	EU-level mapping	
Research Infrastructure (RI) Platform[100]	Research Infrastructure Services for Renewable Energy (RISEnergy) project is dedicated to fostering a long-term, coordinated research effort among leading private companies and research institutions to advance energy technologies within the EU.	***
Aviation through the RINGO project funded under Horizon 2020[101]	The aim of RINGO is to deliver a cohesive and coordinated approach for the identification and assessment of the needs, gaps and overlaps for strategic aviation research infrastructures in Europe; and to analyse potential sustainable business models and funding schemes for maintenance and improvement of existing and development of new research infrastructures. The inventory includes 350 RIs operated mostly by research organisations and universities, but also by private companies.	*
EREA Catalogue	European catalogue of research infrastructures operated by EREA members (association of European aeronautics research establishments). Provides searchable information about	**

[100] Retrieved from: https://risenergy-project.eu/research-infrastructure-ri-platform/
[101] RINGO project. https://cordis.europa.eu/project/id/724102/reporting

	facilities, laboratories, and capabilities, mainly in aeronautics and related fields.	
Websites of OITBs	The websites of the Open Innovation Test beds list members' RI&TI established across EU that have a focus on AdMa.	***
BioPilots4U Database	A European database listing open-access pilot and demo facilities for bio-based processes and bioeconomy applications. Includes detailed profiles of facilities, available equipment, and contact information.	**
M-ERA.Net Clusters and competence centres[102]	This mapping aims to support the transnational networking of clusters and competence centres in the thematic areas of M-ERA.NET.	**
Mobility with a mapping of living labs and test beds by the EIT Urban Mobility KIC[103]	The EIT Urban Mobility conducted an inventory of mobility living labs in the Pan-European region. Living labs are special settings aimed at testing and demonstrating the viability and scalability of new solutions in real-life conditions by engaging stakeholders, citizens and the local community.	*
Bioeconomy, with a database of European Open Access Pilot and Demo Infrastructures for the bioeconomy through the COPILOT project funding by Circular Bio-based Europe Joint Undertaking (CBE JU)[104]	The COPILOT project aims to create a comprehensive database of open access bioeconomy infrastructures embedded into a self-sustainable platform across Europe.	*

[102] Retrieved from: https://www.m-era.net/other-joint-activities/clusters-and-competence-centers
[103] EIT Mobility, https://www.eiturbanmobility.eu/city-club/mobility-living-labs/
[104] Circular Biobased Joint Undertaking (CBE JU), https://www.cbe.europa.eu/projects/copilot

Wind power technology (Interreg Inn2Power)[105]	Under the Interreg Inn2Power project, Testfacilities.eu - a user-friendly web-based marketplace allowing companies to browse a full directory of international test facilities for the offshore wind industry – was created.	*
Forthcoming mapping of RI&TIs in the fields of Biomedical, Clean Hydrogen, Circular Materials, Superconducting Accelerator & Magnet technology and Microelectronics (RITIFI)[106]**.**	The project RITIFI will map RI&TIs across the following dimensions Biomedical, Clean Hydrogen, Circular Materials, Superconducting Accelerator & Magnet technology and Microelectronics. Preliminary mapping has already resulted in more than 100 RI&TIs.	**
MERIL project (Mapping of the European Research Infrastructure Landscape)[107]	The MERIL project redesigned and implemented of comprehensive database of pan-European Research Infrastructures. The portal is no longer updated.	**
Clean and Renewable Energy Industries[108]	The report presents a mapping of technology centres that provide advanced TIs and their services for industry across the 27 EU Member States, encompassing the seven key technology domains of Clean and Renewable Energy Industries (CREI). This report, based on a data-driven approach and using a web scraping methodology, provides a mapping of nearly 1400 technology centres.	*

[105] Retrieved from: https://northsearegion.eu/inn2power/about/
[106] Retrieved from: https://ritifi.eu/deliverables/
[107] Retrieved from: https://portal.meril.eu/meril/
[108] European Commission: Directorate-General for Research and Innovation, Van de Velde, E., Braito, N., Van Roy, V., Pereira, T. et al., Mapping of Technology Infrastructures supporting clean and renewable energy industries in Europe, Publications Office of the European Union, 2024, https://data.europa.eu/doi/10.2777/028028

European Network of Living Labs (ENOLL)[109]		The members of this network are living labs, which provide real-life test and experimentation environments that foster co-creation and open innovation 119 living labs that are part of this network, and located in one of the EU-27 Member States.	*
Metabuilding[110]		The metabuilding ecosystem enables actors from the built environment sector to stay up to date on latest sustainable innovations, find collaboration partners for development and business activities, showcasing products and solutions, testing and certification supports, with 412 organisations and 37 clusters mapped.	***
National-level mappings (EU)			
Austrian Research Infrastructure Database[111]	**Austria**	The Federal Ministry of Education, Science and Research (BMBWF) makes available a public research infrastructure database as an information platform to support the cooperative use of research infrastructure in science, research, business and industry in Austria in cooperation with the Austrian Economic Chamber (WKO) and the Federal Ministry of Digital and Economic Affairs (BMDW).	*
Ministry of Education, Youth and Sports – Roadmap for RIs	**Czechia**	The Roadmap lists Research Infrastructures in Czechia, as well as in Europe and the Americas across a range of research disciplines, including	*

[109] Retrieved from: https://enoll.org/
[110] Retrieved from: https://www.metabuilding.com/
[111] Retrieved from: https://forschungsinfrastruktur.bmbwf.gv.at/de

2023–2026 (Czech Republic)		some with relevance to AdMa research. The Roadmap is a static PDF. Infrastructures are listed and described including contact details.	
Danish "Test facilities" ("Testfaciliteter")[112]	**Denmark**	The mapping collected approximately 400 facilities, about 50% of which are provided by GTS institutes, about 48% by universities and 2% by business.	**
BMBF-Initiative MaterialDigital[113]	**Germany**	An initiative of the German Federal Ministry of Education and Research (BMBF) to digitize materials science and engineering. Provides data models, standards, and a network of infrastructures working on digital representations of materials.	**
Leichtbauatlas[114]	**Germany**	A German online atlas of lightweight construction actors, projects, and infrastructures. Includes manufacturers, research centres, and technology platforms working on lightweight materials and production.	***
ESFRI and National ESFRI Roadmaps[115]	**Multi-MS**	Research Infrastructures developed by ESFRI (64 in total) have also been mapped[116]. At the national/regional level, large RIs are mapped and identified in the national ESFRI Roadmaps[117].	**
Materials equipment	**Netherlands**	Search here for existing materials science equipment	***

[112] Retrieved from: https://teknologiskinfrastruktur.dk/
[113] Retrieved from: https://dgm.de/materialsweek/2025/program/md-bmbf-initiative-materialdigital
[114] Retrieved from: https://leichtbauatlas.de/de/
[115] Retrieved from: https://www.esfri.eu/national-Roadmaps
[116] Retrieved from: https://Roadmap2021.esfri.eu/projects-and-landmarks/view-the-table/
[117] Retrieved from: https://www.esfri.eu/national-Roadmaps

database of four technical universities		available at any of the four Dutch technical universities (Delft University of Technology, Eindhoven University of Technology, University of Twente and Wageningen UR). Currently, only equipment at TU Delft and UTwente is still visible.	
Polish Roadmap of Research Infrastructures	**Poland**	The Roadmap lists 65 Research Infrastructures in Poland across a range of research disciplines, including some with relevance to AdMa research. The Roadmap is a static PDF. Infrastructures are listed and described, but specifics such as contact details are not provided.	*
R&D centres (CBR list, Poland)	**Poland**	The page lists the enterprises that have been granted R&D status by the Ministry of Development and Technology. It contains the names of the infrastructures and hyperlinks to their webpages.	*
Mapeamento das infraestruturas tecnológicas nacionais – 2020[118]	**Portugal**	Portugal has undertaken a comprehensive mapping and Roadmapping exercises to catalogue and strategies the development of its TIs. In its 2020 publication, "Mapeamento das infraestruturas tecnológicas nacionais – 2020," 161 entities are classified as TIs.	**
EERTIS – Research Infrastructure Directory	**Romania & Slovakia**	A searchable directory of research infrastructures in Romania and Slovakia. Provides descriptions of facilities, available equipment, and services.	*

[118] Retrieved from: https://arquivo.ani.pt/media/5890/mapeamento_infraestruturas_tecnologicas_nacionais_2020_vfinal_.pdf

Mapping of Spanish project AM@ESP[119]	**Spain**	The digital platform that integrates and allows searches of the centres, research groups and projects linked to research in this area, as well as companies that have expressed interest in learning about their progress and results.	***
Materplat[120]	**Spain**	The Spanish Materials and Nanotechnology Platform has included in their website a map of capacities of their members	***
ICTS: Unique Scientific and Technological Infrastructures[121] **(Spain)**	**Spain**	The Spanish national network (ICTS) of major research infrastructures across disciplines. Includes facilities in materials science, nanotechnology, and advanced manufacturing. Public inventories list equipment, services, and access conditions	**
Inventory of National and International Test Bed (INIT)[122]	**Sweden**	The purpose of the Inventory of National and International Test Bed (INIT) Capacity was to strengthen Swedish innovation capacity through better organisation of test bed capacity in Sweden and internationally and increasing the internationalisation of Swedish test beds, attracting more international clients to use the existing test beds and invest in new ones. A total of 143 test beds provided data for the inventory.	***
TiraMiSO project[123]	**Sweden**	The project TIraMISO, which was launched in 2023, builds	***

[119] Retrieved from: https://materialesavanzados.es/mapa_en.php?menu=mapa&lang=en
[120] Retrieved from: https://materplat.org/herramientas/capacidades/
[121] Retrieved from: https://www.mapa.gob.es/es/pesca/temas/innovacion/mapa_icts
[122] Retrieved from: https://www.ri.se/en/expertise-areas/projects/inventory-of-national-and-international-test bed-capacity-init
[123] Retrieved from: https://mediabank.businessfinland.fi/l/DqFJsQxWt_tR

		on the experiences of INIT and will includes an update of the mapping of Swedish test beds.	
National level mappings (Japan, UK and US)			
Advanced Research Infrastructure for Materials and Nanotechnology[124]	**Japan**	The database provides a catalogue of material and nanotechnology relevant public sector technical facilities and instruments of its 25 members across Japan. The various network members list the available facilities and devices and provide a short summary and pictures of every piece of equipment. They also indicate if it is available for public and/or private research. Conditions need to be checked while contacting the relevant equipment/facility provider.	***
NIMS-ARIM Equipment list	**Japan**	The Advanced Materials Research Infrastructure (ARIM) project builds upon Japan's Nanotechnology Platform Project focusing on "Materials that exhibit innovative functions through quantum and electronic control" and "Technologies for Advanced Material recycling". As part of the project, the Ministry for Education, Culture, Sports, Science and Technology developed an equipment page listing AdMa equipment available at 6 Japanese RI&TI facilities	**
NSF Major Facilities List	**US**	The mapping lists 20 Major Facilities supported by the US National Science Foundation. The list contains the name of the facility and information regarding the programme	*

[124] Retrieved from: https://www.qst.go.jp/site/arim-english/

		officers for each. The list is not sorted by discipline or technology area	
NSF Mid-scale Research Infrastructures list	**US**	The mapping lists 57 Mid-scale Facilities supported by the US National Science Foundation. The list contains the name of the facility and information regarding the programme officers for each. The list is not sorted by discipline or technology area	*
InfraPortal[125]	**UK**	The UK's Research and Innovation Infrastructure Portal contains information on 829 infrastructures. Additional infrastructure will continue to be added to the Infraportal, but there are no current plans to run the wider landscape (mapping) analysis exercise again.	**
The US Department of Energy provides a mapping of the facilities of the National Labs and Labs Partnering Service[126]	**US**	The mapping is done by classifying facilities by technology areas and location, rather than by types of services or users (e.g. no distinction is made between RIs and TIs). Facilities can be filtered around nine technology areas including: Aerospace and Defence, Automotive, Energy and Utilities, Healthcare and Life Sciences, Higher Energy Physics, Information and Communication Technology, Manufacturing and Industrial, Material Sciences, Micro and Nano Technology.	***
Mappings of RI&TIs by research organisations across EU (covering all types of RI&TIs, including Advanced Materials)			

[125] Retrieved from: https://www.infraportal.org.uk/
[126] Retrieved from: https://www.labpartnering.org/

AIT (AT) – inventory of labs[127]	**Austria**	Provides an overview of AIT projects by seven operated laboratories (Digital Safety & Security, Energy, Health and Bioresources, Innovation Systems and Policy, Technology Experience, Transport Technologies, Vision, Automation and Control).	**
JOANNEUM Research – Materials Research Infrastructure	**Austria**	Profiles of JOANNEUM's research infrastructures focusing on materials development, characterisation, and processing.	***
KU Leuven Research Infrastructure[128]	**Belgium**	Overview of KU Leuven's research infrastructures across disciplines. Includes engineering and manufacturing-relevant facilities.	*
Brno University of Technology – Research Infrastructure[129]	**Czechia**	Listings of infrastructure and equipment at Brno University of Technology. Covers materials, production technologies, and related fields.	**
DTI (DK) –List of testing laboratories[130]	**Denmark**		**
Aalborg University Research Infrastructure)[131]	**Denmark**	A detailed inventory of equipment and infrastructures at the Institute of Materials and Production. Includes advanced manufacturing tools and materials characterisation facilities.	**

[127] Retrieved from: https://www.ait.ac.at/en/laboratories
[128] Retrieved from: https://view.kuleuven.be/infrastructure
[129] Retrieved from: https://www.vut.cz/en/rad/infrastructure
[130] Retrieved from: https://www.dti.dk/testing/
[131] Retrieved from: https://vbn.aau.dk/en/organisations/institut-for-materialer-og-produktion/equipments/

Tallinn Technical University (EE)[132]	**Estonia**	Lists laboratory services focused on providing services for companies	*
University of Helsinki equipment	**Finland**	The mapping lists the equipment available at the University of Helsinki for each infrastructure managed by the university. The list can be searched but no filters are available. The list is not sorted by any discipline or technology area. Contact details are provided.	**
Aalto University Equipment[133]	**Finland**	Searchable catalogue of equipment and research infrastructures at Aalto University, including those in manufacturing, materials processing, and nanotechnology.	**
Institut Polytechnique de Paris Research Laboratories[134]	**France**	Listings of research labs, centres, and infrastructures at Institut Polytechnique de Paris. Includes facilities in materials, nanotechnology, and manufacturing processes.	**
CEA, an ad hoc inventory of Technology Infrastructures[135]	**France**	List of infrastructures is available and maintained at the level of the institutes within CEA	**
CEA LETI[136]	**France**	11 large-scale TIs listed on their website, examples include: Cleanrooms (11,000m2 of facilities, 600 Research engineers, 50 patents per year, cutting-edge pre-industrial equipment) and Nanocharacterisation platform	*

[132] Retrieved from: https://taltech.ee/en/cooperation/for-company/scientific-equipment-and-laboratory-services
[133] Retrieved from: https://research.aalto.fi/en/equipments/
[134] Retrieved from: https://www.ip-paris.fr/recherche/departements-laboratoires-centres-et-projets-de-recherche/laboratoires
[135] Retrieved from: https://www.cea-tech.fr/cea-tech/english/Documents/technology-platforms-booklet.pdf
[136] Retrieved from: https://www.leti-cea.com/cea-tech/leti/english/Pages/Applied-Research/Facilities/researchfacilities.aspx

		(€35m investments, 3,600m2 of equipment, 100 research engineers).	
Fraunhofer ISE - institute for Solar Energy Systems - list of R&D infrastructures[137]	**Germany**	List of R&D infrastructures. Some examples of TIs include Centre for High Efficiency Solar Cells - Technologies for highest PV efficiency values, Centre for Heating and Cooling Technologies - Examination and characterisation of equipment and components for use in building services engineering	**
Fraunhofer IMS - institute for Microelectronic Circuits and Systems - List of infrastructures and equipment[138]	**Germany**	List of infrastructures and equipment. Some examples of TIs include Infrastructure 0.35 ¬µm CMOS Fab & Microsystem technology Lab&Fab.	**
Karlsruhe Institute of Technology – Research Infrastructures[139]	**Germany**	Overview of KIT's large-scale research infrastructures and technology platforms. Includes materials science, nanotechnology, and manufacturing capabilities.	*
Riga Technical University – Research equipment and services (Use.Science platform)	**Latvia**	Inventory of equipment available at the Riga Technical University and other partners in Latvia and internationally. The list can be browsed based on the organisational unit, manufacturer, facility, or through a range of filters.	**
TNO (NL) – inventory of "lab facilities"[140]	**Netherlands**	Inventory of "lab facilities" consists of facilities such as Quantum Information Technology Test Facility,	**

[137] Retrieved from: https://www.ise.fraunhofer.de/en.html
[138] Retrieved from: https://www.ims.fraunhofer.de/en/Infrastructure.html
[139] Retrieved from: https://www.kit.edu/research/research_infrastructures.php
[140] Retrieved from: https://www.tno.nl/en/technology-science/labs/

		Geothermal Energy Lab, Energy Storage Platform, Carnot Lab, Faraday Lab, Seaweed Lab, Biofuels Lab, Mollier Facility.	
TUDelft – includes a list of research facilities[141]	**Netherlands**	List of research facilities that are used to conduct research for business and industry. They range from wind tunnels, a chip facility, high voltage laboratory and nuclear reactor to serious gaming and product evaluation	*
Lukasiewicz network	**Poland**	Lists core facility laboratories, such as Clean Rooms for Materials Science & Engineering Centre	**
Fahrenheit universities	**Poland**	An alliance of three Polish universities in Gdansk offering shared research infrastructures in engineering, materials science, and production technologies.	**
Tecnalia (ES) – inventory of infrastructures[142]	**Spain**	Inventory of infrastructures includes 110 facilities	**
Tekniker inventory of infrastructures[143]	**Spain**	Tekniker in their website provides the list of research areas, solutions, technologies, labs, and technological services	***
Chalmers University of Technology (SE) list of RIs[144]	**Sweden**	According to the university, the concept of a research infrastructure includes everything from advanced real or virtual labs to test beds, large databases, computer capacity for large-scale calculations and magnificent	**

[141] Retrieved from: https://www.tudelft.nl/en/research/research-facilities
[142] Retrieved from: https://www.tecnalia.com/en/infrastructure
[143] Retrieved from: https://www.tekniker.es/en/specialized-laboratories
[144] Retrieved from: https://www.chalmers.se/en/infrastructure/

		research facilities.27 It includes both RIs and TIs as per the EU definitions.	
KTH Royal Institute of Technology Research Infrastructures[145]	**Sweden**	Catalogue of infrastructures and facilities at KTH. Includes labs and platforms for AdMa and production technologies.	**
Mappings of RI&TIs by research organisations in UK			
N8 Shared Equipment Inventory System	**UK**	The portal lists all the equipment available at universities part of the N8 network. It can be searched by equipment, facility, university or through keywords	**
Catapult network[146]	**UK**	The UK's network of technology and innovation centres supporting industrial sectors. Includes centres with advanced manufacturing capabilities (e.g. High Value Manufacturing Catapult).	**
Other relevant inventories of research organisations & other relevant initiatives to identify RI&TI operators			
ESFRI NATIONAL Roadmaps		27 Roadmaps of Research infrastructures. Some of the mapped RIs are related to AdMa	*
European Monitor of Industrial Ecosystem (EMI) – Technology Centres' mapping[147]		Technology centres in this database are public or private organisations carrying out applied research and close-to-market innovation in digital, green and other advanced technologies. It contains 394 centres in its online version, 497 in its validated offline version to which this consortium has access, which	**

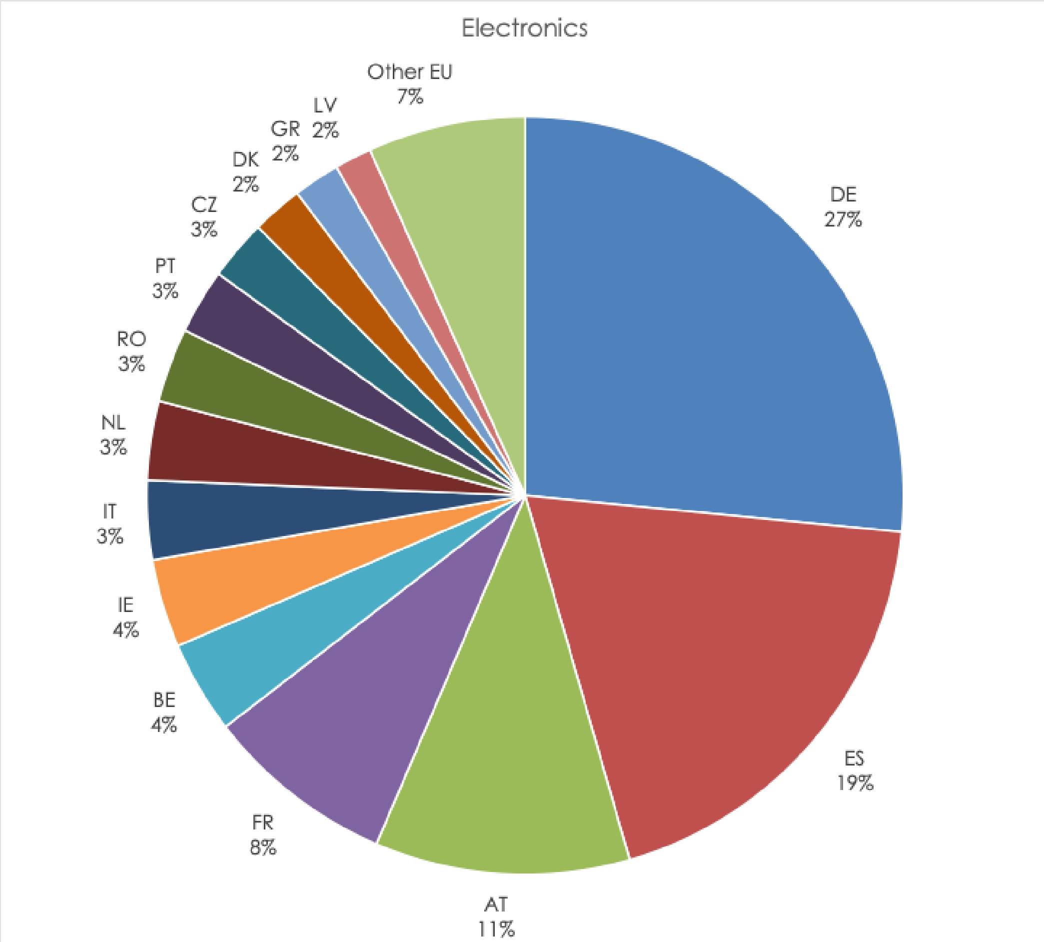
[145] Retrieved from: https://www.kth.se/en/forskning/forskningsinfrastrukturer/kth-forskningsinfrastrukturer-1.858996
[146] Retrieved from: https://catapult.org.uk/about-us/why-the-catapult-network/
[147] Retrieved from: https://monitor-industrial-ecosystems.ec.europa.eu/technology-centre/mapping

	comply with three qualitative criteria for inclusion to the database: 1) providing services to industry and SMEs, 2) being active in at least one of the Advanced Technologies for Industry, and 3) being active in the higher TRL.	
EDIH Catalogue[148]	Funded under DEP aim to accelerate the level of digitalisation of businesses. To that end, they play an important role in fostering the accessibility to TIs of a large spectrum of private actors, including non-tech SMEs. This especially takes place through the "test before invest" service. Example of DIHs offering "Test Before Invest". Owner of the mapping – DG Connect	**
List of the Open Innovation Test Beds (OITB)[149]	Launched within the Horizon 2020 Work Programme 2018-2020 and are defined as a set of entities, providing common access to physical facilities, capabilities and services required for the development, testing and upscaling of nanotechnology and AdMa in industrial environments." The objective of the Open Innovation Test Beds is to bring nanotechnology and AdMa within the reach of companies and users to advance from validation in a laboratory (TRL 4) to prototypes in industrial environments (TRL 7).	***

[148] Retrieved from: https://european-digital-innovation-hubs.ec.europa.eu/edih-catalogue
[149] Retrieved from: https://op.europa.eu/en/publication-detail/-/publication/486a8502-0673-11ee-b12e-01aa75ed71a1/

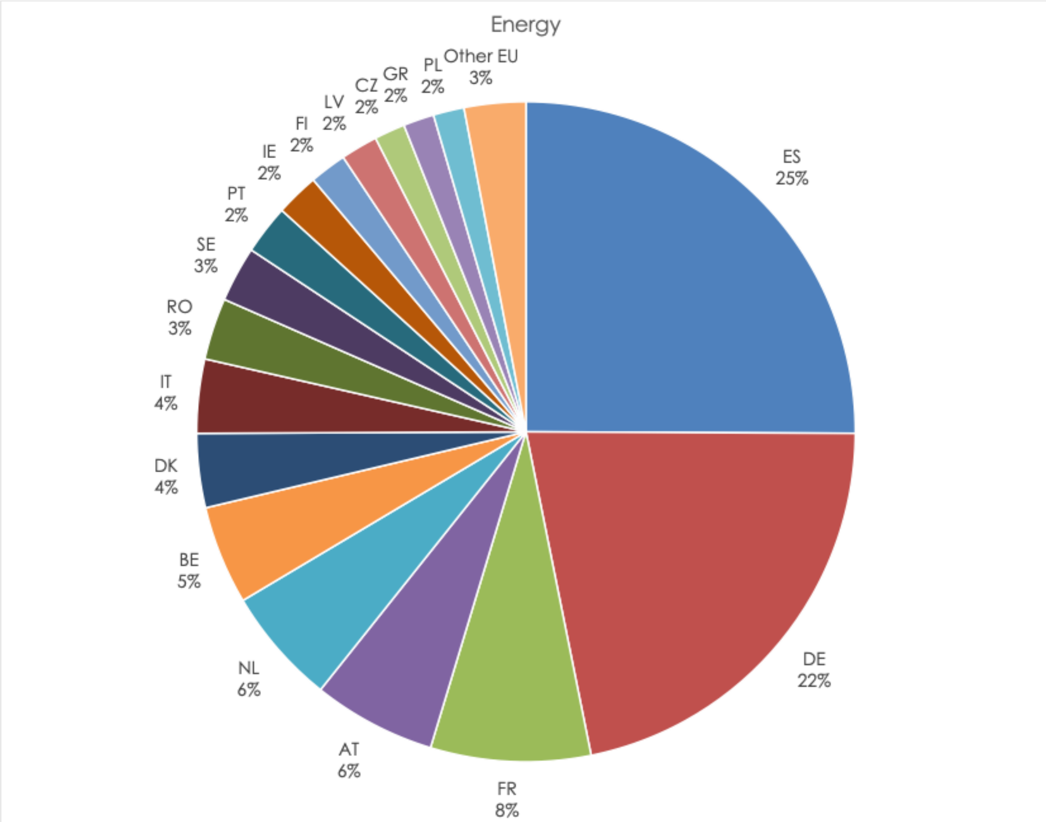
Appendix D Additional figures

Figure 17 EU AdMa RI&TIs with a focus on electronics sector by country



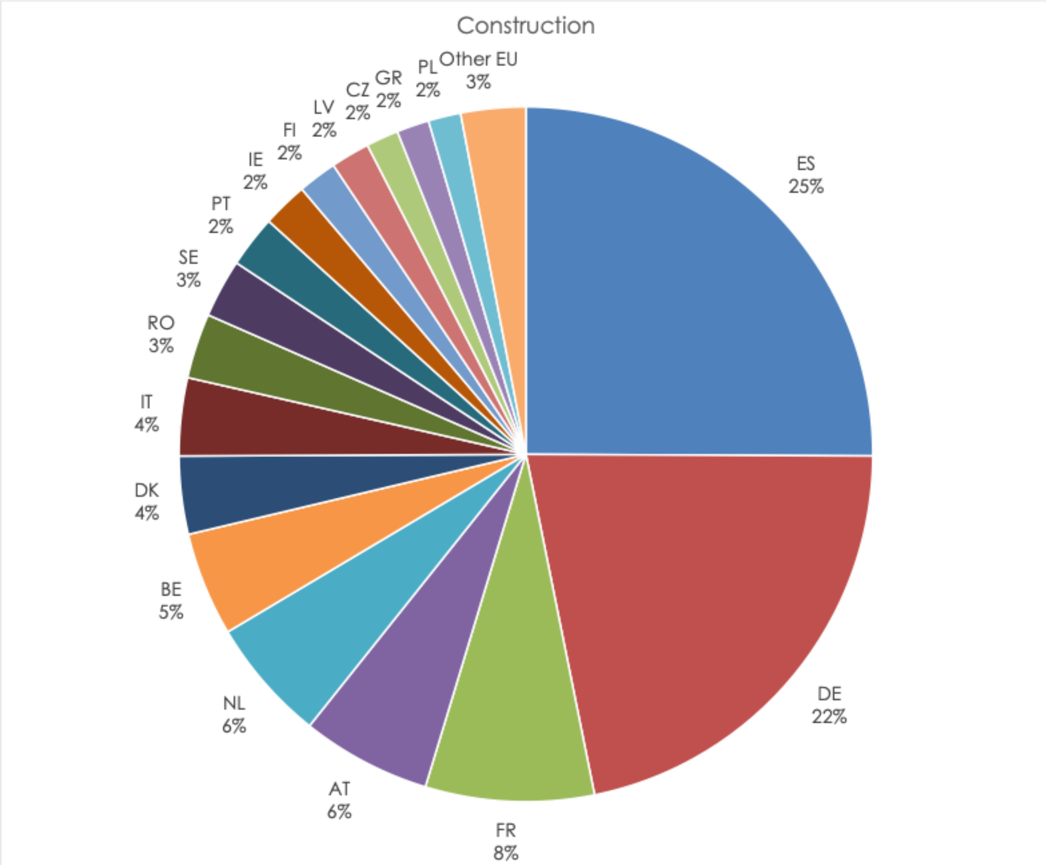
Source: Technopolis Group. Results based on web-crawling analysis implemented by GlassAI

Figure 18 EU AdMa RI&TIs with a focus on energy sector by country



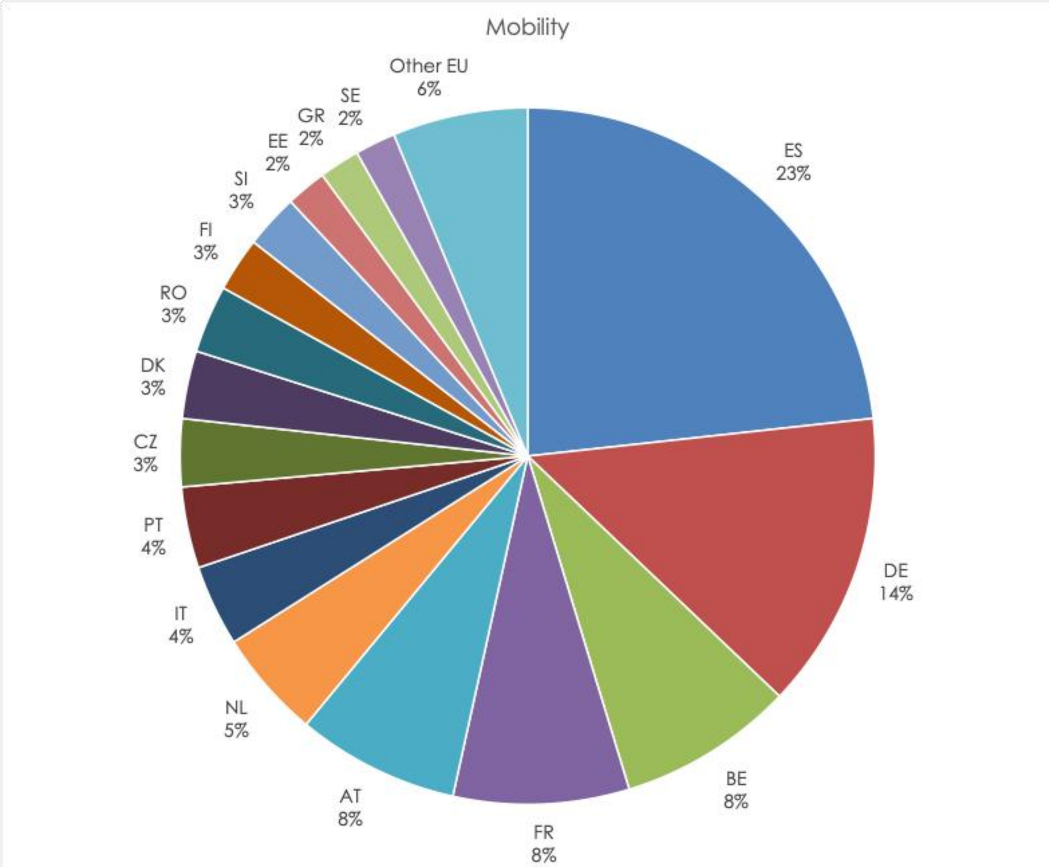
Source: Technopolis Group. Results based on web-crawling analysis implemented by GlassAI

Figure 19 EU AdMa RI&TIs with a focus on construction sector by country



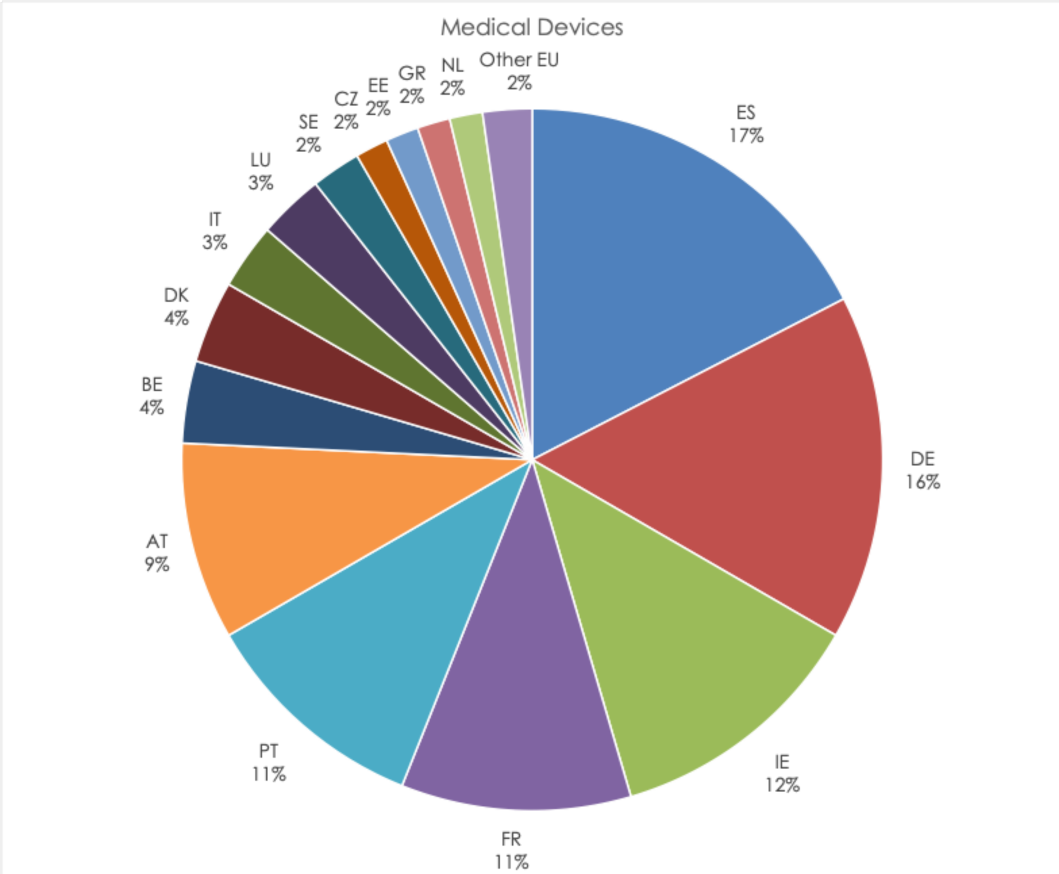
Source: Technopolis Group. Results based on web-crawling analysis implemented by GlassAI

Figure 20 EU AdMa RI&TIs with a focus on mobility sector by country



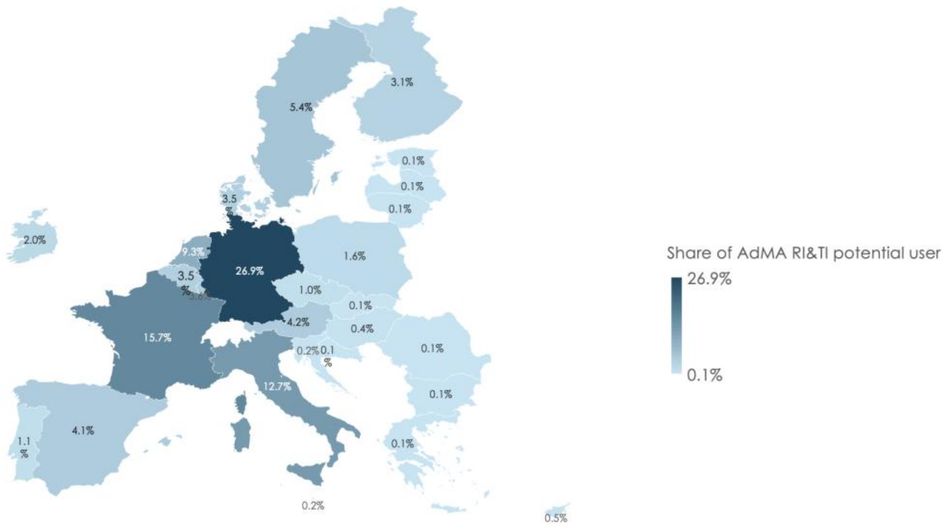
Source: Technopolis Group. Results based on web-crawling analysis implemented by GlassAI

Figure 21 EU AdMa RI&TIs with a focus on medical devices sector by country



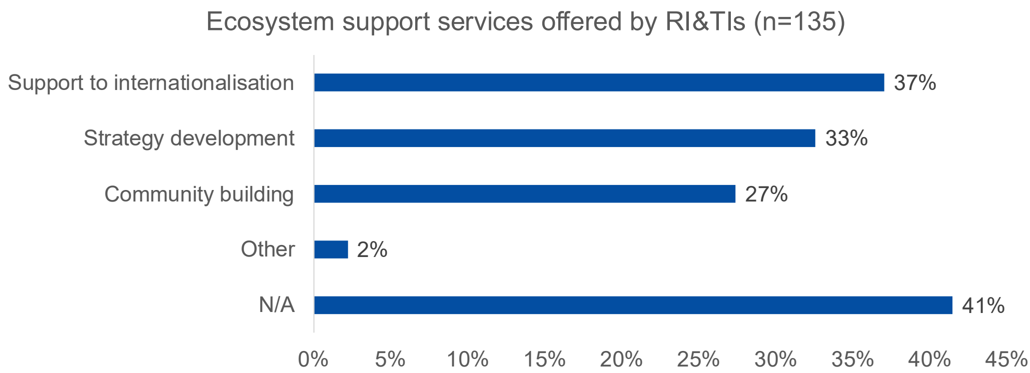
Source: Technopolis Group. Results based on web-crawling analysis implemented by GlassAI

Figure 22 Distribution of potential AdMa RI&TIs users across EU.



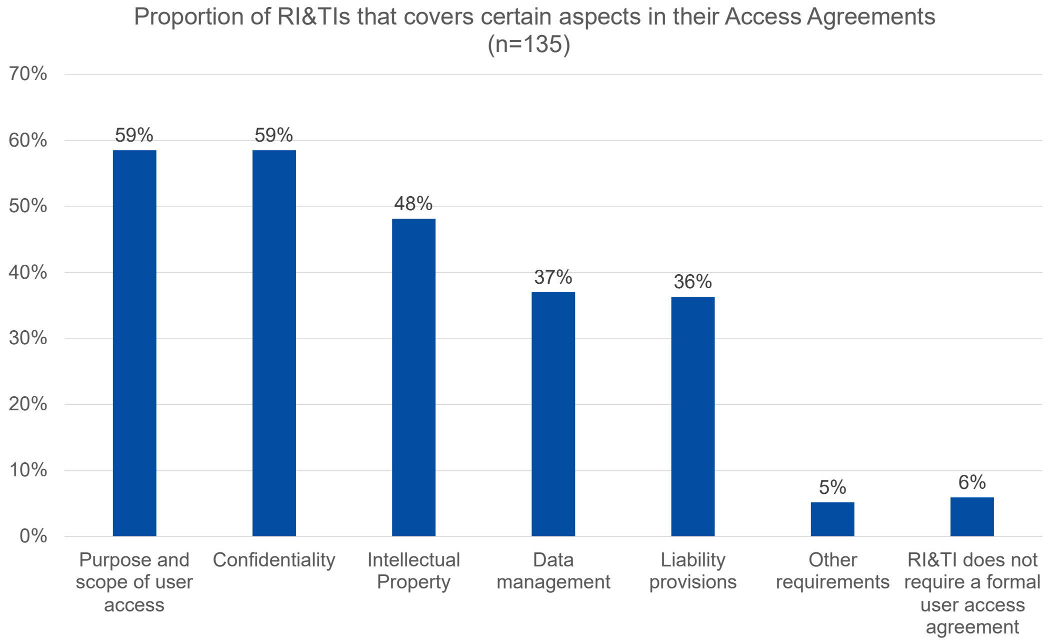
Source: Technopolis Group. Results based on PATSTAT, Orbis IP and Crunchbase.

Figure 23 Ecosystem support services from AdMa RI&TIs.



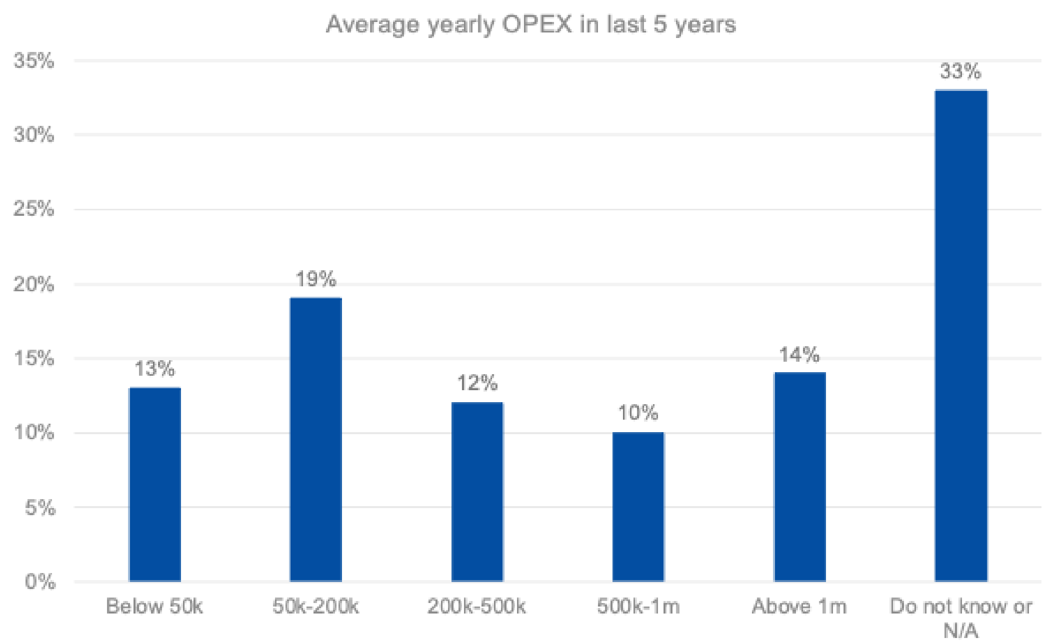
Source: Technopolis Group (2025) based on results from RI&TI AdMa mapping survey. Values do not add to 100% due to multiple-choice answers.

Figure 24 Overview of modalities included in the RI&TI access agreements



Source: Technopolis Group, based on AdMa RI&TI survey results. Values do not add to 100% due to multiple-choice answers.

Figure 25 Average Yearly Operational Expenditure (OPEX) over the last 5 years



Source: Technopolis Group, based on AdMa RI&TI survey results.

Appendix E Summary of developed case studies

E.1 Case study 1: Access conditions to AdMa TIs

This case study examines how industrial users, particularly SMEs and start-ups, access Advanced Materials (AdMa) Research and Technology Infrastructures (RI&TIs), the barriers they face, and measures that can facilitate effective collaboration. It draws on surveys, interviews, and a validation workshop with RI&TI providers and industry stakeholders.

Users access AdMa Technological Infrastructures (TIs) through fee-for-service contracts, collaborative projects, EU or international networks, and funding-supported schemes such as vouchers. The user journey typically involves identifying needs, selecting a suitable infrastructure, formalising access through agreements covering scope, IP, and confidentiality, and using the infrastructure with technical support. Many infrastructure providers foster ongoing collaboration through follow-up support or longer-term partnerships, helping SMEs integrate infrastructure capabilities into their innovation processes. One example of cascade funding is the Green SME Project[150] that enable infrastructure providers and users to identify the key challenges for improving sustainability of the manufacturing companies. This model has been implemented for the first time for materials and components repair in defence.[151]

Despite the availability of multiple access routes, SMEs and start-ups face challenges including financial constraints, administrative complexity, scheduling and operational limitations, misalignment with industrial timelines, fragmentation of the infrastructure landscape, unclear service standards, regulatory barriers, and IP uncertainties. Geographical distance and limited virtual access further hinder engagement.

To overcome these barriers, effective measures include dedicated liaison units, technology-transfer offices, and tailored support services; proactive outreach, ecosystem-building, and intermediaries; flexible access models, standardised contracts, and targeted funding; as well as cross-border collaboration, remote access, and mobility schemes that expand participation across Europe.

E.2 Case study 2: Cross-border collaboration of TIs

Cross-border collaboration of Technology Infrastructures (TIs) allows for pooling resources for the development of Advanced Materials, offering industry access to state-of-the-art facilities, specialised pilot lines, test beds and knowledge, that would otherwise be difficult to access. Such collaboration also contributes to fostering territorial cohesion and EU's technological sovereignty. However, as the evidence gathered by this study suggests, such collaboration does not happen systematically across the EU. The available examples are concentrated in regions with well-developed industrial and innovation ecosystems, yet, even here, they continue to face several challenges. The Solliance partnership between Dutch and Belgian TIs presented in this study is a case in point. The transition to a more predictable funding based on a multi-year programme approach rather than a project approach, coupled with strategic alignment of funding sources across regional, national and EU levels and regional R&I priorities would be key to fostering cross-border TI collaboration in Advanced Materials.

[150] Retrieved from: https://greensmehub.eu/the-greensme-project/
[151] EU Funding & Tenders Portal. EDF-2023-DA-MATCOMP-MJR-CBDIN - Technologies and processes for maintenance, joining and repair through an innovation test hub

E.3 Case study 3: Research Infrastructures and Technology Infrastructures (RI&TIs) collaboration

Research infrastructures and Technology Infrastructures (RI&TIs) collaboration can be a powerful accelerator of advanced materials development when RIs offer their cutting-edge research facilities and TIs their testing and validation services. However, RI&TIs collaboration faces several obstacles related to funding, access, governance, knowledge and strategic policy alignment. The collaboration examples underscore the importance of building trust and common vision given differing interests and constraints of RIs and TIs, as well as a clear allocation of roles and responsibilities between partners. The EASI-STRESS project experience covered by this case study demonstrates how mobilising different funding sources for staff training allowed to ensure the continuity of collaboration and an industrial service offer post-project. Moreover, ensuring a commitment to collaboration at the level of organisational strategy provided a solid basis for work on joint protocol development. Overall, RIs and TIs collaboration could be strengthened through a combined service offering to companies and the introduction of additional incentives for collaboration such as joint calls and funding schemes. Furthermore, harmonisation of access conditions, procedures, data and IP rules and clear delimitation of services to be provided by each partner can help promote RI&TIs collaboration.

E.4 Case study 4: AdMa RI&TI and Open Innovation Test Beds (OITBs) collaboration

Open Innovation Test Beds (OITBs) provide support to industry, particularly small and medium-sized enterprises (SMEs), by offering technical and non-technical services. As OITBs are expected to provide a full range of services along the innovation process, cooperation among member Research and Technology Infrastructures (RI&TIs) within the OITB consortium is inherently required and is sometimes even extended to include new members to address customers' needs. Furthermore, OITBs are also expected to coordinate and network with other OITBs to contribute to a more open and connected ecosystem. Cross-OITB collaborations have taken place in the form of, for example, organising joint events, sharing information, resources and platforms, and, more recently, creating joint service portfolios. Still, several barriers hinder these cooperative activities, and our study presents possible solutions to address these issues in terms of strategic alignment and objectives, coordination mechanisms and governance, and communication and engagement.

E.5 Case study 5: OITB sustainability and governance

Open Innovation Test Beds (OITBs) provide support to industry, particularly small and medium-sized enterprises (SMEs), by offering technical and non-technical services. OITBs are expected to continue functioning independently after the project period, but stakeholders have identified that achieving financial sustainability is a significant challenge. During the project period, OITBs have defined their own governance and business models differently and they are working on marketing and advertising their services. However, challenges remain particularly regarding service affordability for SMEs, as well as branding and visibility. Our study provides several recommendations to address these challenges, including in defining the business model, attracting customers, and guiding them to appropriate services.

E.6 Case study 6: AdMa RI&TI collaboration with EDIHs and other digital EU instruments

EDIHs (European Digital Innovation Hubs) provide several important services to companies in the Advanced Materials (AdMa) sector. Consequently, collaborations between Research and

Technology Infrastructures (RI&TIs), EDIHs, and other EU digital initiatives present a number of opportunities. Notably, EDIHs can enable the integration of digital and infrastructure services, support the digitalisation of RI&TIs, connect end users with RI&TIs, and serve as channels for RI&TIs to provide their services with public funding support. There are, however, a number of operational challenges preventing further collaboration between RI&TI and EDIH. In addition to EDIHs, Testing and Experimentation Facilities (TEFs) and AI Factories present further opportunities to support the digital aspects of materials research, which can be leveraged to support AdMa innovation.

E.7 Case study 7: Spain's Advanced Materials Programme of the Complementary R&D&I Plan (AM@ESP) mapping

This case study examines Spain's Advanced Materials Programme of the Complementary R&D&I Plan (AM@ESP) as an example of how a Member State has approached the mapping of research and Technology Infrastructures (RI&TIs) in the field of Advanced Materials. Its purpose is to extract the key lessons that can inform the design of a future EU-level single entry catalogue supporting Advanced Materials research, development and industrial uptake.

AM@ESP was launched as part of the Spain's Science, Technology and Innovation Strategy (2021-2027) and forms one of eight thematic pillars of the national Complementary R&D Plans co-funded through the Recovery and Resilience Facility. The Advanced Materials Programme mobilised €53m between national and regional budgets and engaged with seven autonomous communities, targeting infrastructure upgrades, strategic research lines, talent development and cross-regional collaboration. As the digital platform accompanying this plan, AM@ESP was developed to map, structure and give visibility to the research groups, technology centres and projects supported in the programme.

The catalogue offers a structured view of entities across the programme's four strategic lines (2D materials, energy materials, smart/functional materials and cross-cutting integration actions). It covers 96 groups and entities, 22 research infrastructures and 72 funded projects, with a strong geographic concentration in Valencia and Madrid. AM@ESP also functions as a digital integration layer, providing searchable access to capabilities and facilitating collaboration across regions and institutions. Its governance relies on shared national-regional oversight, with data entry delegated to individual institutions and coordinated by regional scientific leads. While this bottom-up model captures detailed expertise, it leads to uneven update frequency and highlights sustainability concerns: no permanent authority has been mandated to maintain the platform after the programme funding ended.

The programme has generated significant outputs: 42 new equipment items, 566 publications, 13 patents and 14 company collaborations. The catalogue has improved visibility, access and coordination for users, policymakers and infrastructure operators. However, its partial scope and dependency on project-based funding raises risks of obsolescence. Drawing from AM@ESP, the case study identifies lessons for a future EU single-entry catalogue.

Appendix F Validation workshop summary notes

This workshop is part of **the Study on the Uptake of Advanced Materials** commissioned by the **European Commission's Directorate-General for Research and Innovation (DG RTD)**, led by Technopolis Group together with partners (EFIS, GlassAI, DTI, Fraunhofer, Tecnalia and Tekniker). The Study contributes to the implementation of the European Commission communication Advanced Materials for Industrial Leadership1. The findings of the study will also contribute to the upcoming Advanced Materials Act.

Within this context, the Study aims to collect evidence and analyse the landscape of Research and Technology Infrastructures (RI&TIs) in the field of Advanced Materials. The specific objectives and scope of the study are summarised in the figure below.

- **Overarching Goal:** collect evidence and analyse the Research and Technology Infrastructure (RI&TI) landscape in the field of Advanced Materials
- **Specific Objectives:**
  - Map and analyse the available RI&TIs
  - Assess the current state of the RI&TI landscape
  - Identify users' needs
  - Identify and assess the existing gaps
  - Analyse the collaboration patterns for these infrastructures
  - Provide guidance for a single-entry catalogue
  - Consider the use and further deployment of the catalogue for other EC initiatives
  - Provide examples stemming from the RI&TIs landscape of three third countries

Scope:

- Emphasis on **industrial uptake** and service provision beyond local/regional ecosystems
- **5 priority areas**: Energy, Mobility, Construction, Electronics, Health
- Identification of **dual-use potential** of EU RI&TIs
- **Multi-level approach** spanning EU, national and regional levels for the EU-27, and three benchmark countries: Japan, UK and US
- **Alignment with the recent RTI strategy**

The objective of the interactive validation workshop is to present and validate/finetune the preliminary study results. The workshop will be structured into three parts:

- **AdMa RI&TIs landscape**: this part will focus on TI landscape in the field of Advanced Materials, key findings (including sectoral & service coverage & industrial needs, trends, gaps and challenges).
- **Access to AdMa RI&TIs**: this part will discuss the key challenges, cost-saving actions and good practices facilitating access to AdMa RI&TIs, including presentation and validation of guidance for the single-entry catalogue.
- **Collaboration modalities**: building regional, national, cross-border collaboration between RI&TIs and between RI&TIs and other EU initiatives such as OITBs, EDIHs, – challenges, good practices and suggestions for effective collaboration.

The workshop attracted 150 participants from EU representing AdMa RI&TI operators (technical universities, RTOs, OITBs) and national policy makers.

F.1 Summary of session 1 on the RI&TIs landscape in the field of Advanced Materials

The first exercise explored how the current landscape of RIs and TIs supports the uptake of Advanced Materials in EU. Experts were invited to reflect on sectoral coverage, types of services offered, industrial needs and gaps in the present ecosystem. Their interventions draw from direct operational experience across RIs, TIs, accelerators, public and intermediary organisations, providing a grounded picture of how EU infrastructures function in practice and how they respond to industrial demand.

General gaps in the EU AdMa RI&TIs landscape

Based on the discussion, the following general gaps were identified:

- **Access & Awareness (Mapping / Visibility):** Participants highlighted that SMEs often face difficulty identifying the relevant RI&TIs and understanding how these infrastructures can support their specific challenges. Many companies struggle to navigate the complex landscape of facilities, services, and material capabilities, especially when their needs involve particular formats, batch sizes, or processing conditions. Limited awareness of available characterisation, metrology, and standards related services further compounds the issue. For SMEs located outside major innovation hubs, physical distance to specialised centres creates an additional barrier. A more accessible, EU wide overview of infrastructures and their services was seen as essential to improve clarity and facilitate entry points for industry.

- **Collaboration & referral mechanisms between RI&TIs**: Experts noted that cooperation between RI&TIs remains uneven. Facilities working in similar domains do not always coordinate their activities, and users are not consistently directed to the infrastructure best suited to their needs. This limits the ability of companies, especially new entrants, to access optimal expertise and capacity. Participants emphasised the need for more structured referral pathways and collaborative frameworks to ensure a coherent user journey across EU's distributed capabilities.

- **Critical raw materials & resilience**: The discussion revealed gaps related to secure access to raw materials and the development of Advanced Materials that can substitute critical inputs. Several experts stressed that RI&TIs should strengthen their support for materials related to resilience strategies, including substitution, recovery, and alternative material solutions. These capabilities are increasingly relevant given ongoing supply chain vulnerabilities.

- **Digital, Artificial Intelligence (AI) & computational capabilities**: Participants identified uneven availability of modelling, simulation, and computational tools across infrastructures. While some facilities offer advanced digital metallurgy or AI assisted material development, these capabilities are not widespread. There is a growing need for infrastructures that integrate digital and physical testing environments, such as combining AI with additive manufacturing, robotics, or automated characterisation. Challenges were also noted in data management, including inconsistent definitions, limited interoperability, and insufficient tools to link material development with validation processes, especially in circularity related applications. More comprehensive support is required for studying material behaviour under real world operating conditions.

- **Funding & sustainability (CAPEX / OPEX / Instruments):** Participants highlighted ongoing challenges related to financial sustainability. Many RI&TIs rely on short term or regional funding schemes, which limits their ability to support cross-border users and maintain services once project funding ends. Infrastructures often lack adequate operational budgets to host SMEs, even when capital investment has been secured. Experts also noted insufficient early stage or feasibility funding for companies working at high technology readiness levels but low market maturity. More coordinated EU demand signals would help infrastructures plan investments and sustain capacity in the long-term.

- **IP management & technology transfer**: Issues were raised regarding the management of IP and technology transfer processes. Companies often require guidance on freedom to operate assessments or navigation of third-party patents, and infrastructures differ significantly in their internal IP procedures. The lack of consistent, transparent licensing frameworks can slow down the transition from research to commercial application. Participants also highlighted the need for stronger support mechanisms that bring material developers and product developers together earlier in the innovation process.

- **Regulatory & state aid barriers**: Experts pointed to uncertainties surrounding state aid rules for industrial access to RI&TIs. Ambiguous or restrictive interpretations can delay collaborations or limit the types of services that infrastructures are permitted to offer. More broadly, regulatory burdens and administrative complexities were seen as contributing to extended time to market for new materials, particularly for SMEs seeking cost effective pathways to comply with safety or environmental requirements.
- **Scale-up & pilot production capabilities**: Several participants drew attention to the scarcity of pilot scale facilities that can support companies transitioning from laboratory scale material development to pre-commercial production. SMEs often require multi kilogram batch production, materials compounding, or TRL level testing beyond what research infrastructures typically provide. Some infrastructures indicated that they lack the resources or space to expand capacity despite user demand. The absence of accessible, commercially oriented pilot level services creates a significant bottleneck in the EU innovation chain.
- **Sustainability, circularity & safety requirements**: Participants underlined gaps in infrastructures supporting recycled materials, integrated recycling processes, and environmental impact assessments. As companies face growing regulatory pressure to demonstrate sustainability performance, RI&TIs need stronger capabilities to support material testing aligned with environmental and safety frameworks. The integration of Safe and Sustainable by Design principles was identified as an area where capacities are still developing and not yet consistently available.
- **Strategic capacity gaps**: Experts noted emerging shortages in human and technological capacity in strategic material domains, such as microelectronics and advanced components for unmanned aerial or underwater vehicles. These gaps risk constraining EU's ability to develop and scale technologies that depend on Advanced Materials with high strategic value.

Sector-specific gaps in the AdMa RI&TIs landscape

Based on the discussion, the following sector specific gaps were identified:

- **Energy**: Participants noted that infrastructures supporting Advanced Materials for the energy sector lack adequate capabilities for testing materials under realistic or extreme operating conditions. This includes limited availability of facilities capable of conducting high temperature or harsh environment experiments, which are essential for validating materials used in energy production, storage and conversion. Experts also pointed to insufficient capacity for studying *in operando* material behaviour, an increasingly important requirement for catalysis, electrochemistry and energy related functional materials. In addition, the sector requires more advanced modelling and simulation tools to predict material performance throughout its lifecycle, yet such capabilities remain uneven across infrastructures.
- **Mobility**: In the mobility sector, gaps were identified in infrastructures supporting lightweight materials, thermal management solutions and advanced composites. Participants highlighted that RI&TIs often lack the modelling capabilities and experimental facilities needed to optimise thermal behaviour in mobility applications, including materials for electric vehicles and aerospace components. There is also a shortage of mid-scale facilities able to produce composite or polymer formulations at relevant batch sizes, which hinders validation for automotive, aerospace and rail applications. Recycling capacities relevant to mobility materials, such as polymer or composite recovery, also remain limited, affecting circularity objectives in this sector.
- **Electronics**: Experts emphasised significant gaps in materials development and testing capabilities for microelectronics and semiconductor components. EU lacks sufficient RI&TIs dedicated to Advanced Materials used in integrated circuits, microchips and high-performance electronic devices. Participants pointed to a shortage of specialised testing platforms, cleanroom adjacent infrastructures and integration environments capable of

supporting reliability assessment, material compatibility testing and high precision characterisation. Human expertise and R&I capacity in this domain were also considered insufficient to meet rising demand in strategic technologies, including components for advanced communication systems and autonomous platforms.

- **Construction**: Sector specific gaps in the construction domain relate primarily to formulation work, polymer and composite development, and the validation of new materials for durability and safety. Participants noted that SMEs in this sector often require multi kilogram test batches of materials such as coatings, binders or polymer mixtures to perform structural or performance testing; however, infrastructures offering such intermediate scale production remain scarce. Facilities able to support environmental performance assessments, including long-term degradation or exposure testing, are also limited. This constrains the sector's ability to adopt innovative materials that meet both regulatory and sustainability requirements.
- **Healthcare and medical devices sector**: In the medical devices sector, participants highlighted gaps in infrastructures providing specialised testing related to biocompatibility, environmental and health safety, and regulatory compliance. Companies often require material performance data aligned with stringent medical standards, yet the availability of RI&TIs offering such services is inconsistent. Capacities to evaluate environmental imprint, chemical safety or material interactions in biological settings remain uneven across EU. As regulatory expectations grow for Advanced Materials used in medical applications, these gaps impede timely development and market readiness.
- **Other sectors**: Experts identified additional gaps that cut across sectors such as packaging, consumer goods, catalysis, advanced manufacturing and industrial tooling. In these areas, infrastructures often lack capabilities for circularity aligned testing, such as validating recycled materials, assessing contamination, or supporting safe and sustainable by design methodologies. Facilities supporting lignocellulosic feedstock processing were described as fragmented, limiting progress in bio-based materials for multiple sectors. Furthermore, gaps in modelling and simulation tools were noted for toolmakers and manufacturers who require advanced thermal and mechanical prediction models to optimise high performance materials in industrial environments. These limitations reduce the ability of diverse industries to integrate Advanced Materials into their products and processes.

Emerging user needs and future consideration for RI&TIs

Based on the discussion, the following emerging needs for the next three to five years were identified, together with considerations for how RI&TIs should evolve to meet them:

- **Increasing demand for digital, AI driven and predictive materials development**: Participants expect a rapid increase in the use of advanced modelling, simulation and AI assisted design tools to accelerate materials discovery and improve performance prediction. Companies will increasingly require infrastructures that integrate digital and physical workflows, allowing simulations to directly inform experiments and vice versa. RI&TIs will need to strengthen their computational capacity, invest in data driven methodologies and adopt common data standards to ensure interoperability. The ability to model operando behaviour and link material development with validation and circularity requirements will become essential.
- **Greater need for pilot scale production and mid TRL validation**: Across sectors, SMEs and scale-ups will require infrastructures that support intermediate scale production, including multi kilogram batches, compounding, formulation work and process validation above TRL 5. Participants anticipate that the gap between laboratory level testing and industrial production will widen if RI&TIs cannot expand their scale-up capabilities. Infrastructures will need to consider investments in pilot level equipment, modular production units and flexible testing environments to enable companies to validate materials before major capital commitments.

- **Stronger emphasis on sustainability, circularity and safe and sustainable by design**: User needs related to sustainability will intensify as sectors face stricter environmental and regulatory requirements. Companies will seek infrastructures capable of providing comprehensive environmental footprint assessments, evaluating recycled feedstock quality, supporting chemical safety testing and embedding safe and sustainable by design methodologies throughout the development process. RI&TIs will need to expand their capabilities in recycling technologies, contamination analysis and circularity focused validation frameworks to meet rising expectations.
- **Rising importance of materials for strategic technologies**: Demand is expected to grow for materials supporting strategic sectors such as microelectronics, energy storage, hydrogen technologies, unmanned systems and advanced manufacturing. Users in these areas will require infrastructures offering specialised testing conditions, access to advanced characterisation equipment and expertise in handling critical raw materials and substitution pathways. RI&TIs will need to reinforce strategic capacities, including high precision testing platforms, advanced cleanroom environments and expertise in reliability and integration challenges.
- **Increased need for cross infrastructure coordination and seamless user pathways**: As Advanced Materials development becomes more complex, users will depend on smooth transitions between facilities offering complementary capabilities. Emerging needs include more structured referral mechanisms, shared service frameworks, and integrated user journeys connecting modelling, prototyping, characterisation and scale-up. RI&TIs will need to strengthen coordination mechanisms, develop joint access schemes and clarify their service offerings to ensure users can move efficiently through EU's distributed infrastructure landscape.
- **Strengthening of data management, standards and quality assurance**: Participants anticipate growing demand for infrastructures that can provide reliable, comparable and standardised data. This includes data formats, experimental protocols, metrology standards and certification schemes. Companies will increasingly expect RI&TIs to deliver validated data that can be directly used in regulatory submissions or industrial decision making. Infrastructures will need to invest in standardisation activities, implement robust quality systems and participate in EU or international harmonisation efforts.
- **Enhanced support for IP, tech transfer and industrial integration**: In the next few years, companies, particularly SMEs, will require clearer pathways for protecting intellectual property and transitioning prototypes into commercially viable technologies. RI&TIs will need stronger internal expertise in licensing, freedom to operate analysis and early collaboration between material developers and end product manufacturers. Improved tech transfer processes, transparent contractual frameworks and dedicated support services will be critical to help firms advance toward industrialisation.

F.2 Summary of session 2 on AdMa RI&TIs accessibility

This second session examined how companies, and especially SMEs, access Advanced Materials RI&TIs. The objective was to identify the most significant barriers that hinder industrial use of these infrastructures, highlight practices that have proven effective in facilitating access, and assess whether the proposed guidance for a single-entry catalogue aligns with the real needs. The discussion focused on the practical, regulatory and structural dimensions of access, and explored the ways in which a catalogue could help, provided that it is designed to complement existing mechanisms rather than add further complexity.

Access challenges for SMEs and industrial users

Based on the workshop discussion and the inputs shared on the Mural board by the participants, the following access challenges were identified:

- **Cost and financial barriers**: Many SMEs and start-ups face significant financial constraints that limit their ability to access RI&TIs. Participants highlighted that the cost of services, combined with the time needed to prepare requests, often exceeds what small firms can afford. Public support schemes are not always available or easy to obtain, and SMEs typically lack dedicated staff to navigate complex funding instruments. The absence of straightforward funding mechanisms, such as vouchers or cascade funding, was repeatedly mentioned as a barrier. Differences in pricing across regions can also deter cross-border access, particularly when SMEs from lower income regions face higher service prices elsewhere in Europe.
- **Visibility, awareness and ability to identify the right infrastructure**: Experts noted that many SMEs are unaware of relevant facilities or struggle to understand which RI&TIs can support their specific needs. Identifying the right contact point within an infrastructure is also time consuming, and communication costs can be high. This leads to situations where companies miss out on expertise that already exists within the ecosystem. Several participants emphasised that SMEs often do not know what type of testing, equipment or methodology they require, which complicates the process of matching industrial problems with the right RI&TI capabilities. A lack of user-friendly search tools was cited as a persistent issue.
- **Limited support for defining needs and preparing access requests**: SMEs frequently require guidance to frame their technical needs, prepare test plans and interpret results. Participants emphasised that many companies lack the internal expertise to define the scope of experiments or to select the appropriate technologies. Current RI&TI services are often research oriented rather than tailored to applied, time sensitive industrial needs, leaving SMEs without the necessary support to structure their engagement. The absence of integrated service pathways means SMEs must navigate multiple infrastructures independently, which they often do not have the resources to do.
- **Regulatory and state aid constraints**: State aid rules were identified as a major obstacle to improving industrial access. Many RI&TIs funded through public programmes are restricted in how they can offer services to companies, particularly when demand originates from SMEs operating under commercial pressures. Participants noted that publicly funded infrastructures lack clear criteria for allocating access to industrial users, and that compliance with state aid rules can slow down or block collaboration. Additional regulatory burdens further complicate access, especially when infrastructures must adhere to research-oriented procedures rather than industrial timelines.
- **Intellectual property, liability and trust issues**: Participants pointed to a lack of clarity around IP ownership as a recurring challenge. Companies expressed concerns about confidentiality, potential leakage of proprietary knowledge and the risk that infrastructures may claim ownership of results. Some infrastructures lack standardised licensing practices or internal expertise in technology transfer, creating uncertainty for users seeking to scale-up innovations. There are also concerns about liability when infrastructures undertake work on commercially relevant products, as research grade guarantees may not meet industrial needs. These issues can erode trust, particularly for SMEs who cannot afford legal uncertainty.
- **Organisational and administrative burdens**: Accessing cutting edge equipment is often associated with scheduling delays, administrative procedures and long internal approval cycles. Several participants emphasised that RI&TIs can be perceived as slow, with processes that do not align with the fast execution timelines expected by SMEs and start-ups. Companies sometimes choose to build their own facilities or turn to international providers, including in Asia, when EU infrastructures cannot respond quickly enough. Frequent changes in industrial personnel and lack of continuity within companies further complicate the access process.

- **Fragmentation, competition and lack of coordination within the ecosystem**: Participants highlighted a lack of coherence across the EU RI&TI ecosystem. Fierce competition between infrastructures can sometimes undermine accessibility, as facilities do not always perceive themselves as complementary assets. The absence of structured networking mechanisms or coordinated user pathways means that infrastructures rarely refer users to one another, even when alternative facilities could offer better solutions. Some infrastructures experience fluctuating demand, which complicates planning and makes the operation of equipment more challenging. Participants called for a stronger, professionalised coordinating role within the ecosystem to ensure coherence, avoid duplication and guide companies more effectively.
- **Limited alignment with industrial needs and market realities**: Several participants observed that RI&TIs remain primarily research driven and are not always adapted to industrial requirements such as speed, cost efficiency or market-oriented validation. SMEs often report that infrastructures do not offer the services they need or lack the production scale capabilities required for industrial testing. There is also a gap between the pace of new materials development and the commercial pressures faced by companies, making it difficult for SMEs to rely on infrastructures that operate on academic timelines. Internal competition within companies, between in house R&D centres and external infrastructures, can also discourage collaboration.
- **Lack of integrated service pathways and support structures**: Many SMEs do not have the time or expertise to navigate multiple infrastructures. Participants noted that SMEs would benefit from integrated service packages that combine technology scouting, testing, data interpretation and scale-up support. Current services are often fragmented, with infrastructures offering isolated capabilities rather than coordinated solutions. A lack of long-term access clarity and limited remote access options further complicate user engagement, particularly for companies located far from major innovation regions.
- **Challenges in using and developing standards**: Participants stressed that the absence of harmonised standards for testing, validation and material characterisation creates uncertainty around cost structures and access procedures. Developing standards requires substantial time and funding, which are not always available. Addressing these gaps would increase the value of existing testing infrastructures and provide more predictable access conditions for industrial users.
- **Gaps in searchability and digital discovery tools**: Workshop participants noted the need for modern discovery mechanisms that allow SMEs to find relevant infrastructures quickly and accurately. Several experts argued that traditional catalogue approaches have been attempted repeatedly over the past two decades with limited success. More dynamic, AI enhanced search tools were suggested as a more viable solution to help SMEs identify the most appropriate RI&TIs and to streamline initial contact processes.

Access recommendations: how to improve access to AdMa TIs

Based on the discussion and the inputs shared on the Mural board, the following recommendations were identified to improve access to Advanced Materials Technology Infrastructures:

- **Strengthen funding mechanisms to support SME access**: Participants emphasised the need for dedicated and streamlined financial instruments to reduce the cost barriers faced by SMEs. Access vouchers were identified as one of the most effective tools, particularly when designed to operate across borders rather than being restricted to national contexts. Several contributors highlighted the importance of simple, fast mechanisms that avoid administrative hurdles, allowing SMEs to access RI&TIs without navigating complex funding landscapes. Shared EU–national–private funding models were proposed to ensure sustainability. Additional targeted schemes, including cascade funding for OITBs, were also recommended.

- **Improve visibility and discovery through modern, user-friendly tools**: Greater transparency and visibility were seen as central to improving access. Participants stressed the need for consolidated, up to date mappings of TI services, supported by intuitive communication channels and digital marketplace tools. While some argued for continued development of catalogue approaches, others noted that AI driven search tools could provide faster, more accurate identification of relevant facilities. Suggestions included federated databases with a single API, user friendly access catalogues, and even large language models trained on TI capabilities, regulations and pricing to help SMEs better understand their needs. Promotion of existing national databases and better dissemination of current solutions were also encouraged.
- **Enhance the role of regional nodes and local contact points**: Regional innovation nodes were frequently described as crucial entry points for SMEs. Participants recommended equipping these nodes with virtual access capabilities to all EU TIs, enabling them to support SMEs in defining needs, identifying appropriate infrastructures and preparing access requests. Establishing local contact points that can translate industrial challenges into technological solutions was also considered essential. Allowing regional support funding to be used across borders would further enhance mobility and access for companies located in less connected regions.
- **Expand remote and virtual access**: Remote access was viewed as an important tool to reduce travel costs, geographical barriers and scheduling constraints. Participants recommended increasing the availability of remote experimentation, virtual consultations and online pre-screening services. Digital access should complement physical visits, providing a virtual hub that allows companies to explore capabilities, understand processes and assess suitability before engaging more deeply with a TI.
- **Promote standardisation, clear access conditions and common terms**: To streamline access and reduce uncertainty, participants emphasised the need for standard terms of engagement across infrastructures. Developing clearer access conditions, harmonised IP rules and common contractual templates would facilitate smoother interactions, reduce negotiation time and build trust between RI&TIs and industry. Standardisation activities should also be supported financially to help infrastructure's structure costs more transparently and ensure predictable access procedures.
- **Strengthen coordination and networking across infrastructures**: Several recommendations focused on improving cooperation between distributed TIs. Participants suggested connecting existing infrastructures at the EU level along relevant value chains, enabling users to move seamlessly across facilities for proof-of-concept validation. Developing roadmapping guidelines, best practices and investment prioritisation frameworks would help align efforts and reduce fragmentation. Some contributors highlighted the need to establish a coordinated working force capable of guiding the evolution of the RI&TI ecosystem, informed by technology scouting and investor engagement.
- **Facilitate transnational access and mobility**: Improving transnational mobility for researchers, SMEs and staff was identified as a priority. Participants recommended strengthening transnational access schemes, offering guidance for virtual access and enabling regional infrastructures to support companies from other regions. Removing regional funding restrictions would allow SMEs to use local support instruments at infrastructures located in other parts of EU, improving fairness and choice.
- **Develop larger, more efficient TI clusters**: To reduce access costs and increase competitiveness, participants recommended building or expanding clusters of TIs that can share resources, expertise and equipment. Larger clusters can operate more productively, meet diverse user needs and provide economies of scale, making access more affordable for SMEs and start-ups. Such clusters would also be better positioned in global competition.

- **Support early engagement and co creation with industry**: Participants highlighted the need for RI&TIs to engage more closely with industry at earlier stages. More time spent by infrastructures meeting companies, understanding needs and advising on technical pathways would improve relevance and accessibility. Workshops offering opportunities to test samples at cutting edge EU facilities were suggested as an effective tool for raising awareness and building trust. Strengthening long-term partnerships with industry R&D centres would help ensure that infrastructure services remain aligned with applied industrial timelines.
- **Invest in skills, training and up skilling**: A cross-cutting recommendation was the need to maintain high quality skills within RI&TIs through continuous training and upskilling. As user needs evolve rapidly, particularly in digital and AI driven materials development, infrastructures must ensure staff can support new techniques, methodologies and regulatory requirements. Training programmes for SMEs were also proposed to help them better understand available tools, interpret results and navigate the access process.
- **Provide targeted tools to support innovation pathways**: Participants suggested that RI&TIs develop digital twins of optimised processes to help SMEs scale materials from development to production. Support tools could also include guidance for registering innovations under initiatives such as JRC's INCITE, assisting SMEs in validating processes and improving readiness for scale-up. These tools can help SMEs reduce risks and accelerate progress toward industrialisation.
- **Promote service centric communication rather than infrastructure centric messaging**: A recurring insight was that SMEs respond better to clear descriptions of services rather than lists of infrastructures. Participants noted that a well-managed, widely publicised catalogue that emphasises available services rather than institutional names would more effectively guide users to the right capabilities. Shifting communication from facility focused to service focused messaging would improve clarity and reduce confusion in the early stages of engagement.

Single entry catalogue: Additional governance modalities, incentive mechanisms and financial sustainability features

Based on discussions, the following incentives would encourage AdMa RI&TIs to participate in the single-entry catalogue:

- **Increased visibility and access to new users**: Participation would make infrastructures more easily discoverable by SMEs, start-ups and industrial actors, helping them attract new users and connect with markets they may not currently reach. By drawing additional users, infrastructures would be able to generate complementary revenue streams.
- **Eligibility for funding instruments connected to the catalogue**: RI&TIs included in the catalogue could benefit from funding mechanisms such as vouchers, cascade funding or catalogues linked support schemes, similar to existing approaches under EIC service provider catalogues.
- **Quality signalling and increased credibility with industry**: Listing in a curated, catalogue would act as a quality indicator for industrial users seeking reliable, results oriented infrastructures, helping build trust and increase confidence in the capabilities of participating RI&TIs.
- **Stronger integration into EU innovation ecosystems**: Participation would reinforce the role of RI&TIs within wider EU programmes and initiatives, helping them align with strategic priorities and benefit from ecosystem-level coordination, visibility and collaboration opportunities.

The following governance related recommendations were identified to ensure the catalogue is effective, trusted and sustainable:

- **Establish a neutral, centralised and independent governance body**: Participants stressed that the catalogue must be governed by an impartial entity, independent from individual infrastructures, to ensure fairness, prevent conflicts of interest and maintain a focus on service-based matching rather than institutional promotion.
- **Learn from past initiatives and avoid fragmentation**: Workshop participants emphasised the importance of avoiding duplication and ensuring that the new catalogue is federated and leverages existing initiatives.
- **Implement robust security, competition and compliance safeguards**: Given concerns about sensitive infrastructure data, governance should integrate strong security protocols and consider implications for competitiveness and competition law. Participants stressed that the catalogue must not expose infrastructures to misuse or create risks to critical facilities.
- **Leverage trusted local actors to support user engagement**: Local intermediaries, such as RTOs, EEN branches, local accelerators and EDIHs, should have a central role in connecting the catalogue with industrial users.

Experts expressed the following considerations to support the long-term financial sustainability of the single-entry catalogue:

- **Establish a mixed funding model combining EU support and long-term framework arrangements**: Participants highlighted that the catalogue is unlikely to be financially self-sustaining through user fees alone. A stable contribution from the EU Commission, potentially through a framework type contract with multi-year renewals, would provide predictable resourcing for maintenance, updates and governance activities. Periodic reviews would help ensure accountability and alignment with evolving policy and industrial needs.
- **Introduce modest subscription or participation fees for TIs**: Some participants supported the idea of small subscription fees for infrastructures joining the catalogue, provided these remain proportionate and do not discourage participation. Alternatives include performance based financial contributions, such as a small commission on services generated through the catalogue. These mechanisms would help offset operational costs while maintaining low barriers for RI&TIs.
- **Implement self-funding or community-based support mechanisms for maintenance**: Beyond EU support, participants proposed exploring light touch, collective mechanisms such as self-funding or crowdfunding approaches to cover ongoing maintenance or incremental upgrades. This could help reduce dependence on short term project funding and foster community ownership of the catalogue.

Overall, it is important to ensure that the catalogue remains focused on economic value for industrial ecosystems. Participants noted that while the catalogue may not be financially self-sufficient, its value lies in supporting local and cross-border industrial development. The financing model should therefore recognise catalogue’s role in strengthening competitiveness and economic activity.

F.3 Summary of session 3 on the Collaboration between Advanced Materials’ RI&TIs – building regional, national cross-border collaboration between RI&TIs and other EU initiatives

This third session explored how collaboration can be strengthened across the wider ecosystem supporting Advanced Materials innovation. This included collaboration between infrastructures, as well as the one between Advanced Materials RI&TIs and other EU-level instruments, such as Open Innovation Test Beds (OITBs) and European Digital Innovation Hubs (EDIHs) and various national and regional initiatives. Participants reflected on the challenges that hinder effective cooperation, shared experiences that illustrate current gaps, and considered suggestions for improving coordination so that SMEs and users can more easily navigate and benefits from the wider ecosystem of support instruments.

Collaboration between RI&TIs

Based on the workshop discussion and Mural inputs, the following structural and operational barriers hinder collaboration between RIs and TIs:

- **Fragmented governance frameworks and lack of coordinated mandates**: Participants highlighted that RIs and TIs operate under diverse governance models, funding rules, cultures, and institutional mandates. At EU and national levels, no formal coordination body exists for TIs, and their relationship to RI focused structures such as ESFRI remains unclear. This institutional fragmentation limits strategic alignment and complicates cooperation.
- **Competition for funding and resources**: Infrastructures often compete for the same funding streams, clients or visibility. With uncertainty around long-term funding for TIs, some RIs fear that increased support for TIs may reduce their own funding opportunities. This competition discourages joint efforts and reduces incentives for collaboration.
- **Lack of harmonised access rules, administrative complexity and incompatible IP frameworks**: Differences in access procedures, data management policies and IP practices create barriers to joint projects. The coexistence of open access requirements (common in RIs) and confidentiality needs (critical for TIs and industry) complicates cooperation. Administrative burdens in multi partner projects further deter joint activities.
- **Legislative and jurisdictional inconsistencies across countries**: Different national legal frameworks for IP, data, liability and confidentiality hinder cross-border collaboration. The lack of harmonised regulations or shared standards makes it difficult for infrastructures to develop coordinated services or long-term partnerships.
- **Limited mutual awareness, insufficient mapping and unclear contact points**: Participants noted that infrastructures often lack knowledge of each other's capabilities, instruments or services. Without a clear overview of TIs comparable to RI mapping exercises, opportunities for synergy remain underexploited. In some cases, actors do not know whom to approach within partner organisations.

Participants identified the following measures to strengthen collaboration:

- **Introduce incentives and targeted funding schemes for joint RI–TI projects**: Dedicated funding calls that require or reward RI–TI partnerships would help reduce competition and promote collaboration. Examples include combined service development projects, shared access schemes or calls under programmes such as INFRA SERV that explicitly support integrated service delivery.
- **Develop joint service offerings and integrated value chain support**: RIs and TIs could collaborate to create comprehensive service packages for companies, especially in areas such as circular materials, surface engineering or hydrogen technologies. Combining analytical capabilities from RIs with piloting and scale-up of TIs would provide seamless support from proof of concept to industrial validation.
- **Strengthen skills development, training and cross learning**: Participants recommended training programmes for RI and TI operators, funders and intermediaries, building on initiatives such as RITIFI. Joint professional development would increase mutual understanding, reduce cultural barriers and foster the emergence of professionals who understand both research and industry-oriented infrastructures.
- **Improve mapping, coordination and strategic planning**: A structured mapping of TIs similar to RI landscape analyses would help clarify capabilities and complementarities.

Annual gatherings, RI–TI summits and joint foresight exercises would support coordinated ecosystem planning, reduce duplication and foster clustering based on specialisation.

- **Launch pilot collaborations and service tailoring phases**: Participants recommended initiating pilot projects where RIs and TIs jointly develop new services (e.g. a chemistry TI and a synchrotron co developing a catalyst characterisation service). These pilots would test collaboration models, identify bottlenecks and demonstrate value to industry.
- **Establish shared guidelines, harmonised access rules and coordination mechanisms:** Developing common guidelines for access conditions, cost models, data treatment, IP rules and service delivery would significantly reduce administrative burdens. Participants also encouraged clearer role definitions and coordination mechanisms to ensure that RIs, TIs, OITBs and ERICs operate as complementary parts of the ecosystem.
- **Promote local proximity collaboration and joint business development**: Leveraging local trusted partners, universities and regional technology nodes can help identify synergies between nearby RIs and TIs. Joint business developers with sector specific missions could work across infrastructures to generate industrial leads, supported initially by EU funding.
- **Enhance digital interconnection and remote collaboration:** Expanding digital tools, modelling integration and virtual access mechanisms would help link RIs and TIs more effectively. Digitalisation also enables new formats of collaboration, such as shared digital twins, virtual training and distributed workflows.

Collaboration between cross-border TIs

Participants identified the following structural and operational challenges that hinder effective cross-border collaboration between European TIs:

- **Fragmented and unsynchronised funding landscapes**: Cross-border collaboration often requires parallel investment from several countries or regions, yet funding calendars, eligibility rules and strategic priorities are rarely aligned. Participants highlighted that misaligned calls and inconsistent regional or national funding instruments make it difficult to develop joint initiatives or sustain shared facilities over time. Short-term project-based funding further inhibits long-term joint planning and does not provide stable resources for collaboration across borders.
- **State aid constraints and regulatory inconsistencies**: State aid rules were cited as a major barrier when cross-border activities involve mixed funding or support to SMEs. Different national interpretations, as well as varying legal and administrative frameworks for IP, data and liability, make it difficult to structure cooperation agreements. These legislative disparities create uncertainty for both infrastructures and industrial users.
- **Competitive dynamics and limited incentives to collaborate**: Participants noted that national or regional TIs are typically designed to boost local competitiveness and therefore lack incentives to cooperate internationally. Competition for funding, industrial clients and visibility can discourage collaboration. Gaps in strategic policy alignment across borders, including limited use of Smart Specialisation Strategies (S3) for joint priorities, further reduce opportunities for cooperation.
- **Asymmetries in industrial capabilities and ecosystem maturity**: Differences in industrial development levels across regions create structural barriers. TIs in less industrialised ecosystems may lack the capacity to contribute fully to cross-border initiatives, while more advanced regions may find cooperation less beneficial. These asymmetries can undermine balanced collaboration and limit opportunities for shared investment.
- **Limited knowledge of other TIs' capabilities and ecosystems**: Participants highlighted insufficient awareness of the broader EU TI landscape. Without clear mapping or transparency on capabilities, TIs struggle to identify complementary partners and avoid

duplication. Language barriers, cultural differences and limited personal networks further constrain cooperation, especially for SMEs attempting to access foreign TIs.

- **Sensitivity of proprietary information and confidentiality requirements**: Sharing proprietary knowledge is often essential for effective collaboration, but companies and infrastructures remain cautious about disclosing confidential information across borders. This concern, combined with inconsistent IP and confidentiality frameworks, can slow down or prevent cooperation.

Several measures were proposed to strengthen and scale cross-border collaboration between TIs, focusing on funding alignment, governance approaches and practical collaboration mechanisms:

- **Align and coordinate funding instruments across regions and countries**: Synchronised calls, co funded programmes and joint programming efforts were widely recommended. Participants stressed that cross-border TIs need predictable revenue models and multi annual funding arrangements at EU and national levels to sustain shared facilities and reduce administrative fragmentation. Moving from project driven to programmatic collaboration would provide greater long-term stability.
- **Engage regional authorities and industry in joint planning**: cross-border collaboration requires active involvement of regional governments and industrial partners. Participants recommended that regional authorities commit funding beyond project lifetimes and participate in shared strategic planning. Stronger industry participation would help ensure alignment with real market needs.
- **Improve coordination and ecosystem-level planning**: Better coordination at EU and transnational levels could reduce duplication, support clustering and foster specialisation. Participants suggested joint foresight exercises, shared roadmaps and cross-border ecosystem strategies, including the use of S3 frameworks to address common industrial challenges.
- **Establish mechanisms for smoother SME access across borders**: Participants recommended giving regional nodes a formal role as the entry point for SMEs wishing to access TIs in other Member States. The regional node would act as the user interface, while the TI in another country would be subcontracted for specific services. This model reduces complexity for SMEs and increases trust in cross-border access pathways.
- **Foster knowledge exchange and trust building activities:** Regular gatherings, cross-border workshops and exchanges of good practices were highlighted as essential ways to build trust, strengthen personal networks and increase awareness of complementary capabilities. Training programmes that help professionals understand different national contexts and collaboration models would further support cross-border engagement.
- **Clarify IP ownership and data sharing frameworks**: To facilitate cooperation, participants emphasised the need for clearer rules on joint IP, confidentiality and data access. Harmonised guidelines or model agreements would significantly reduce legal uncertainty and help TIs collaborate more effectively.

Collaboration between RI&TIs and OITBs

Participants highlighted several concrete challenges that currently limit collaboration between RI&TIs and OITBs:

- **Concerns around sharing proprietary information**: A recurring barrier is the uncertainty over whether and how proprietary or commercially sensitive information can be shared. Both infrastructures and industry users may hesitate to collaborate when confidentiality terms are unclear or when knowledge exchange is perceived as risky.

- **OITBs face structural instability once project funding ends**: Several participants noted that OITBs are often created through EU projects and must later "find a purpose and funding" once initial grants expire. This can push them into short term survival mode rather than enabling long-term strategic collaboration with RI&TIs.

- **Limited knowledge and visibility of each other's instruments and roles**: RI&TIs report a lack of awareness of what OITBs are, what they do and how they operate. Some participants explicitly asked about their added value and pointed out that OITBs are not even listed on the European Commission's website. This lack of basic visibility and mapping makes engagement difficult.

- **Different commercial interests and overlapping services**: RI&TIs and OITBs may end up competing for the same industrial customers or offering overlapping services. This competition reduces incentives to collaborate and can create tension when infrastructures target similar markets.

- **Lack of dedicated funding instruments to support collaboration**: Participants emphasised that there is no clear funding mechanism enabling RI&TIs and OITBs to collaborate or to learn from each other. The absence of schemes designed specifically to facilitate RI–OITB cooperation limits joint activities.

Regarding measures that could strengthen cooperation and unlock synergies between RI&TIs and OITBs, participants have identified the following:

- **Develop integrated service portfolios** and combined single-entry points: Participants recommended integrating RI, TI and OITB service offerings into joint portfolios that provide seamless support from materials design and validation (RI&TIs) to certification, regulatory advice, safety testing and market-oriented services (OITBs). Creating shared or interconnected Single-Entry Points would help users navigate these services more easily.

- **Expand training and mentoring programmes across communities**: Training and mentoring programmes modelled on initiatives such as RITIFI would help bridge cultural, technical and procedural gaps between RI&TIs and OITBs. Such programmes would improve understanding of each other's missions, tools and operational models, enabling smoother collaboration.

- **Strengthen clustering and intelligent grouping of infrastructures**: Clustering related OITBs and RI&TIs, such as in the Convert2Green model, would create larger, more coherent offerings for industry. These clusters could coordinate service development, improve visibility and reduce fragmentation by presenting integrated pathways for industry users.

- **Promote joint service development and pilot collaborations**: Participants suggested launching pilot collaborations to develop new joint services, such as linking advanced catalyst characterisation at RIs with materials validation and certification at OITBs. These pilots would test operational models, provide evidence of added value and support the development of new service tailoring phases.

- **Leverage complementarities between materials validation and regulatory/test bed services**: Participants emphasised that collaboration could help bridge gaps between early validation and commercial readiness. RI&TIs bring early-stage materials design, prototyping and advanced characterisation; OITBs add regulatory support, safety assessment, certification and business services. Similarly, TEFs bring digital capabilities such as AI, robotics and data spaces, complementing materials R&D workflows.

- **Support coordination mechanisms and shared governance approaches**: Coordinated actions among OITBs' single-entry points have already begun, especially for funding and exploitation pathways. Participants recommended continuing these efforts, establishing clear roles, harmonised procedures and stable coordination structures. Joint roadmapping and foresight exercises would help identify priority areas for collaboration.

Collaboration between RI&TIs, and EDIHs and other instruments (e.g. AI factories, TEFS, etc.)

Regarding the collaboration between RI&TIs and EDIHs and other instruments, experts flagged the following obstacles:

- **Concerns about sharing proprietary information**: As in other collaboration settings, uncertainties around confidentiality and the handling of proprietary data remain major obstacles. SMEs and infrastructures may hesitate to engage with additional intermediaries if data protection practices are unclear or divergent.
- **Limited awareness and knowledge of each other's instruments**: Several participants noted a basic lack of understanding of what EDIHs, TEFs, AI Factories actually do. This lack of mutual knowledge prevents RI&TIs from identifying complementarities or collaboration opportunities and reinforces fragmentation.
- **Differences in methodologies, data formats and technical approaches**: Digital oriented instruments often operate with different standards, data models and interoperability practices than RI&TIs. These technical mismatches make it difficult to connect services or develop shared workflows.
- **Perception of competition rather than complementarity:** Participants noted that, for various reasons, RI&TIs and digital instruments sometimes see each other as competitors for visibility, clients or funding, rather than as collaborators. This perception creates institutional distance and limits engagement.
- **Lack of inter-regional and national cooperation frameworks:** Cross regional agreements and national level coordination mechanisms are often missing, making it difficult to organise structured collaboration between the different instruments. Without clear frameworks, collaboration remains dependent on personal networks.
- **Limited incentives and resource constraints:** Established RI&TIs are frequently focused on serving existing stakeholders and do not always have the resources to shift attention to new actors such as EDIHs or TEFs—especially when there is no clear funding incentive. In some cases, collaborations might not align directly with their core mission.
- **Unclear added value of EDIHs and related instruments**: Participants noted that the added value of EDIHs or AI related instruments for RI&TIs is not always clear. Without a clear understanding of what these instruments contribute, RI&TIs may be reluctant to collaborate.

They proposed several concrete measures to strengthen cooperation:

- **Collaborate with Chips Competence Centres and digital infrastructures**: The Chips Competence Centres launched in 2025 provide a promising opportunity for RI&TIs to collaborate on training, dissemination and joint funding schemes. Their semiconductor focus complements several Advanced Materials and manufacturing domains.
- **Organise training and mentoring programmes across communities**: Training initiatives similar to the RITIFI programme could help bridge gaps in culture, methodology and operational approaches between RI&TIs, EDIHs and TEFs. Shared capacity building would improve communication and mutual understanding.
- **Harmonise methods, data formats and technical approaches**: Participants stressed the importance of developing common methodologies, aligned formats and interoperable data structures to make practical collaboration possible. This would facilitate integrated workflows that combine materials, testing and digital capabilities.
- **Facilitate networking, workshops and joint events**: Workshops, conferences and structured exchanges were seen as essential for helping infrastructures “get to know each other” and explore collaboration opportunities. Participants suggested replacing separate,

siloed events (one for EDIHs, one for RIs, etc.) with a single large EU level conference gathering all communities, including research, policy, industry and digital actors.

- **Reduce silo formation and integrate related instruments**: Participants explicitly called for an end to the proliferation of separate European instruments. They recommended bundling existing tools, improving coherence and enabling RI&TIs, EDIHs, TEFs and AI Factories to collaborate within more integrated structures, reducing fragmentation.
- **Build long-term collaboration visions and coordinated planning**: Beyond events, participants emphasised the need for long-term shared strategies and aligned funding to ensure that collaborations with digital instruments are sustainable, rather than ad hoc or project driven.

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This report presents the results of the study on the "Uptake of Advanced Materials," which provides a comprehensive mapping and analysis of the European landscape of Research and Technology Infrastructures (RI&TIs) focused on Advanced Materials. It builds on the European Strategy for Research and Technology Infrastructures and contributes to the preparatory work for the forthcoming Advanced Materials Act. The study maps and assesses RI&TIs across the EU, UK, US and Japan including their services, business models, and role in supporting innovation and scale-up. The study also identifies user needs, key gaps, collaboration patterns, and provides guidance to improve access and coordination to RI&TIs, including through a potential single-entry catalogue.

Studies and reports

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