ERIC FORUM

ERIC Forum Policy Brief

SCALING-UP RESEARCH PROJECTS THROUGH ERICS: IMPACT OF BIG SCIENCE ON THE RESEARCH ECOSYSTEM

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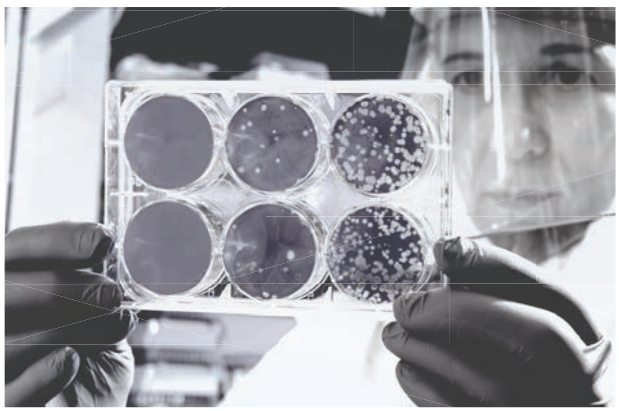

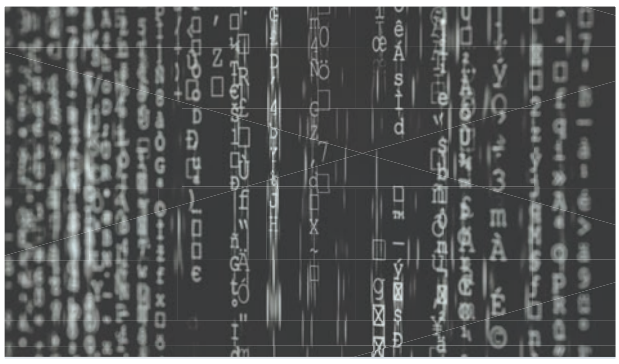

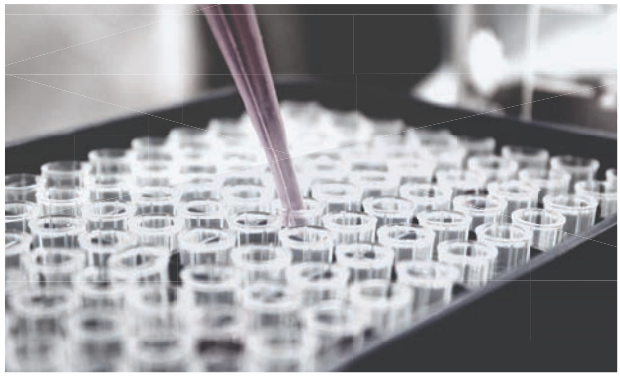

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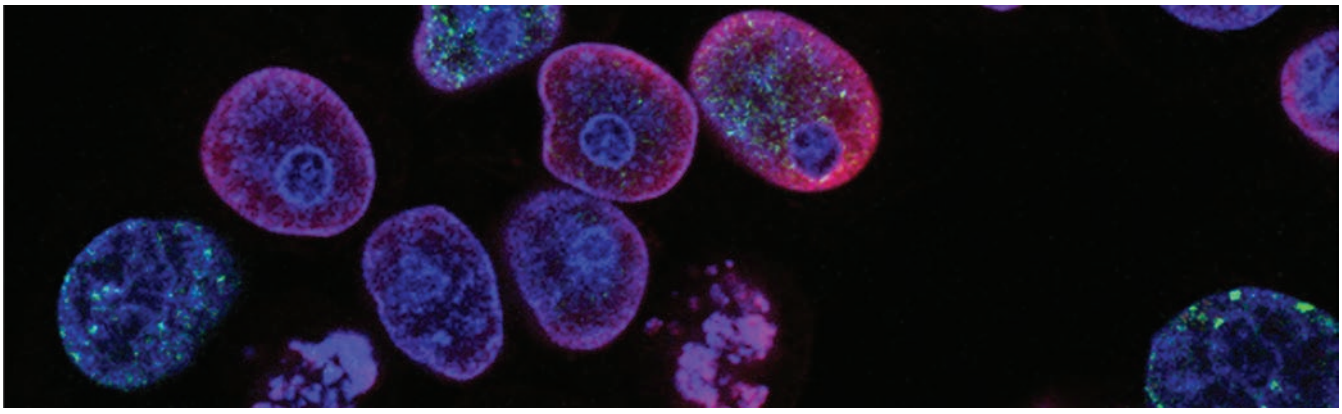
EXECUTIVE SUMMARY

Since their inception, Research Infrastructures (RIs) have been a scientific and technological cornerstone of the European Research Area (ERA), supporting scientific excellence for the advancement of science and its application to societal challenges, ranging from our place in the Universe, to climate change and emerging virus threats, by providing cutting-edge skills, tools and services. European RIs, whether virtual, single-site or distributed, contribute through their network of users, partners and collaborators at local, regional and international levels to science-based activities and communities, building competitive ecosystems and knowledge-based economies. The European Research Infrastructure Consortium (ERIC), with its specific European legal framework and strong multidisciplinary interactions within the ERIC Forum, constitutes a strong foundation and a backbone of the ERA, integrating both service and research activities of many Member States. ERICs are well positioned to scale-up research projects and capacities to reach more researchers and broaden their effectiveness and impact.

Scaling-up Big Science through RIs covers the value chain from basic to applied research with the objective of increasing both access and impact for the players as well as for the society at large. Although the term Big Science is traditionally used to refer to post-Cold War megainvestments in single-site capacities with military connections, here it refers to the Pan-European multidisciplinary, cutting-edge network of RIs which tackles global societal challenges and contributes to sustainable knowledge-based economic growth on a regional scale.



Indeed, one of the key features of European Research Infrastructures, and the ERICs in particular, is their Pan-European network with strong ties with national and regional stakeholders. This interconnection facilitates crosscutting collaborations, sharing of good practices and implementing evidence-based policies. In scaling-up, many of the processes already in place are ready for expansion and adaptation, saving time and resources to get up to speed. ERICs are uniquely positioned to respond to demands that require agile mobilisation and cutting-edge resources, thereby contributing to both the scaling-up of research activities and services as well as their fast uptake, and providing solutions for prevention and mitigation.

As starkly revealed once again by the COVID-19 pandemic, research challenges do not recognise national borders. Cooperation at the organisational level by consolidated multidisciplinary entities, embedded within

their local and regional ecosystems such as ERICs is key in order to mobilise resources to address such global challenges efficiently and effectively.

This second ERIC Forum policy brief showcases the pivotal role of RIs and ERICs in particular in the European R,D&I ecosystem at the interface of science and technology users and providers. The scientific and societal impact of the big investments made in European science through the RIs include direct and indirect spillover effects considering their diverse modes of tackling scientific and societal challenges.

Throughout this policy brief selected case studies present the achievements of ERICs in providing urgent and framework solutions. The case studies illustrate the rich and diverse RI landscape*, activities and scope. In total 24 case studies, domain specific or cross-domain, showcase the breadth and depth of the innovations addressing today and tomorrow's key challenges. Each case study is preceded by a short presentation of the ERIC. The challenges and hurdles to advancement at different levels are presented followed by actionable recommendations to forge the way forward so that the ''ERIC system'' can continue to serve as the "backbone of ERA" within a sustainable framework.

The recommendations to optimise the ERIC research ecosystem and effectively scale-up its contribution to research and socioeconomic impacts are as follows:

1. The added value of Pan-European Research Infrastructures as Big Science instruments should be further underscored among the research community and key stakeholders including the Industry at national and international levels. Global expansion and partnerships with ERICs should be promoted to foster collaborations in global research projects to tackle shared challenges. Moreover, the participation of third-countries in ERICs, if not endorsing the ERIC Regulation, should be encouraged by other different forms, such as participation as strategic partners regulated by a MoU, which could set a favourable context for the collaboration.

2. The benefit of joining and/or collaborating with an ERIC should be manifest when individual partners engage in projects or activities in which they have interest, in order to use the joint capabilities and create synergies. Large-scale interdisciplinary collaborations across RIs and scientific communities mobilising collective intelligence not only benefit the participating entities but promote excellence and greater impact by the prioritisation of research questions and the collaborative design of research protocols.

- Authorship rules, evaluation criteria and career development policies should be developed to promote the participation of research and infrastructure staff in highly collaborative competitive projects.
- The operational and legislative frameworks for data standards, sharing, reuse and analysis should be strengthened.

* ESFRI Roadmap 2021: https://roadmap2021.esfri.eu/media/1295/esfri-roadmap-2021.pdf

3. Member State support for ERICs should be promoted in competitive funding calls in the framework of national programs, supporting the national nodes and hubs and increasing the quality and impact of the proposed activities. The national rules for eligibility should be adapted to allow the participation of ERICs as beneficiaries (for example, they could be beneficiary by applying to the calls through the national nodes or through the seat). ERICs in any Member State, independently of the details of the hosting arrangements, must be clearly recognised as a distinct, international, established institution with its own legal entity as per the ERIC Regulation, including the national ERIC nodes and hubs. The EC must be vigilant to ensure that all the Members States recognise the ERIC entities.

4. Funding mechanisms should be adapted to unfold the full potential of ERICs to meet the needs of large science projects in terms of volume and multinational and cross-border availability, as well as prioritisation criteria in order to fully benefit from the ERIC infrastructure support.

5. ERICs are valuable to Industry. The visibility of these collaborations can be promoted by creating an “ERIC label” that Industry can exploit as a label of excellence. Setting-up an “Industry board” can contribute to maintaining and strengthening collaborations.

6. The EC must maintain its role and support ERICs beyond the preparation phase, through instruments such as the INFRADEV contracts and promoting their participation in all the pillars of the EU Framework Programme, to support and facilitate the international collaboration.

7. Evidence-based policy-making should be supported by strengthening the dialogue between ERICs and policy-makers through dedicated fora to promote regular formal and informal communication.

BACKGROUND

A synthesis of historical accounts of European scientific cooperation through RIs demonstrates their role in unlocking scientific potential in European countries and regions. The global political history connects the two concepts of Big Science and Research Infrastructures. Science and technology have had a critical role in shaping geopolitics; during the race to develop new energy sources, transport systems, military technologies, as several large-scale programs were launched by industrialised countries. However RIs, as open access research platforms in Europe predate this trend[1]. Libraries and collections open to external users were common place since antiquity. More recently, neither the CERN nor the EMBL were connected to traditional "Big Science".

RIs differ thus from the post-Cold War Big Science given their focus on public goods rather than military or national security objectives[2]. The European RI initiative, launched in 2000, was conceived as a powerful means to guarantee scientific coordination, collaboration, and integration between fragmented scientific initiatives and to align European countries' intergovernmental and collaborative interests on a large scale. Since then, a shift of focus towards innovation in a systemic view has occurred in Europe, transforming the landscape.

Nowadays, science is a more active player in societal issues and researchers are asked to develop more effective solutions for a sustainable future. The societal challenge, from now on, is the balance between handling economic contraction while creating new opportunities considering environmental safeguard. "Recovery today and resiliency tomorrow" is more than just hype; it is a call for action. The COVID-19 pandemic effects can be a catalysing factor, but a practical global multiplayer cooperation must overcome fragmentation-related issues. A paradigm shift is required, together with stronger societal cohesion and collaboration in almost all sectors, and policies for accelerating the transition to a knowledge-based economy. Science is one of the fittest means to address significant challenges, including increasing environmental risks, food insecurity, pandemics and other health-related risks. And it is becoming increasingly multidisciplinary for a more comprehensive approach to complex problems. It is a fact that many research projects are operated (and even funded) at a national or regional level.

The cross-cutting nature of Sustainable Development[3] demands a holistic view; the social, economic and natural sciences are asked to contribute to systemic approaches supporting transformative socioeconomic-financial-ecological systems. Increasing research responsibility for societal challenges opens a new scenario for ERICs towards an integrated and cross-domain strategy. Development of pathways for the ecological transition requires planning and diffusion of new technological, economic, social, and innovation models built upon new knowledge in energy production, storage and distribution, natural resource exploitation and environmental monitoring, logistic, resources supply and treatment and health.

1 Stazione Zoologica Anton Dohr set-up in 1875 in Naples, Italy'
2 Investing in Science, Massimo Florio, 2019 MIT Press
3 https://www.un.org/sustainabledevelopment/

INTRODUCTION

Big Science as conceived by the EU through RIs and ERICs represents a fundamental change in the way research is designed, funded and conducted. Although its implementation and impact vary across scientific disciplines, integrated research services rely on two major enablers, the large Research Infrastructures on one hand and on the other the capacities, including Big Data, to exploit, analyse and scale these innovations. Progressively spreading from physics to the environment, health, human and social sciences, this approach has resulted in major scientific achievements with substantial societal impact.

According to the EU definition in Article 2(1) of the Regulation (EC 2021/695)[4] of the Horizon Europe Framework Programme, Research Infrastructure "means facilities, resources and services that are used by the research communities to conduct research and foster innovation in their fields".

However, according to the ESFRI roadmap, European Research Infrastructures represent more than merely large scientific instruments, as they are multinational by essence. In particular, by requiring a minimum of three member countries, the ERIC legal status adds a political dimension[5], as ERICs are also science policy and strategic instruments (ESFRI Roadmaps[6]) for multinational cooperation, unlocking the latent scientific potential, fostering integration of research and innovation in Europe and supporting the development of the European Research Area.

This results in a distinction between national or local facilities, and Pan-European Research Infrastructures (although a significant number of distributed infrastructures build on the federation and the potential integration of national facilities).

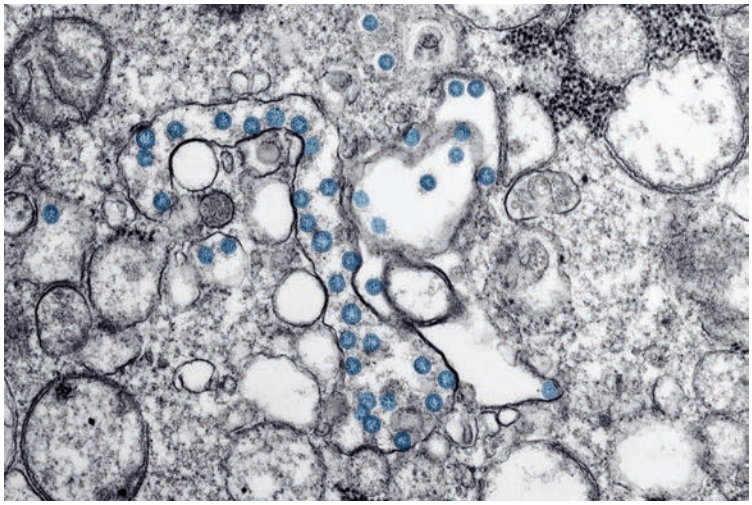
Whether single-sited or distributed, size matters in a highly competitive global scientific environment. High-throughput data generation for example requires expertise on leading-edge technology and methodologies, and appropriate procedures to ensure data quality, reliability and reproducibility. On the other hand, Big Data technology allows optimal use and analyses of this data through data storage facilities, high performance computing, modelling, artificial intelligence, data sharing, curation and reuse. Building on Research Infrastructures and on Big Data technology has resulted in emerging research methods and approaches, for instance the data-driven research in parallel to hypothesis-driven research. Beyond data-driven research, a significant number of new results and achievements would have been impossible without the qualitative and quantitative support of the Research Infrastructures in generating high-throughput quality data (see for instance the use cases described in the following chapters of this policy brief). In addition, these instruments make it possible to address new scientific questions and societal challenges that could not be solved otherwise.

Cooperation between Research Infrastructures acts as a powerful enabler for transdisciplinary research, one of the most promising and innovative areas of frontier science, while infrastructures in closely related areas may cooperate through alliances[7].

Research Infrastructures collaborate as disciplinary clusters, and cross-cluster collaboration allows both cross-fertilisation and support to complex projects requiring multiple technological and methodological expertise.

4 REGULATION (EU) 2021/695 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 28 April 2021 establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013 https://eur-lex.europa.eu/eli/reg/2021/695/oj
5 Big Science and research infrastructures in Europe, Cramer KC and Hallonsten O eds, Edward Elgar Publishing 2020.
6 https://www.esfri.eu/esfri-roadmap
7 EU Alliance of Medical Research Infrastructures, www.eu-amri.org

The prominent role of European Research Infrastructures in the regional integration of research activities across Europe raises a number of challenges, in particular with regards to the optimal use of available resources in terms of human capital, funding of the Research Infrastructure and their supported projects[8] as well as competitiveness and sustainability. As research resources are limited, a critical question for the scientists, the operators of research infrastructures, and the science policymakers lies in the balance, for each individual research project, between the breadth and the granularity of the collected data. The use of Research Infrastructures also impacts the competition vs. cooperation balance among scientific communities: large-scale projects requiring significant resources, foster a collective approach to the prioritisation, design, planning, conduct, analysis, publication and exploitation of the experiment results. Other components of the research ecosystem also have to be considered, including a harmonised regulatory framework, data interoperability, and last but not least, the availability and level of sustainable multinational funding schemes.



8 ERIC FORUM Policy Brief « Funding Models for Access to ERIC Multinational/ Transnational Services" https://www.eric-forum.eu/wp-content/uploads/2020/09/ERIC-Forum_Policy-Brief.pdf

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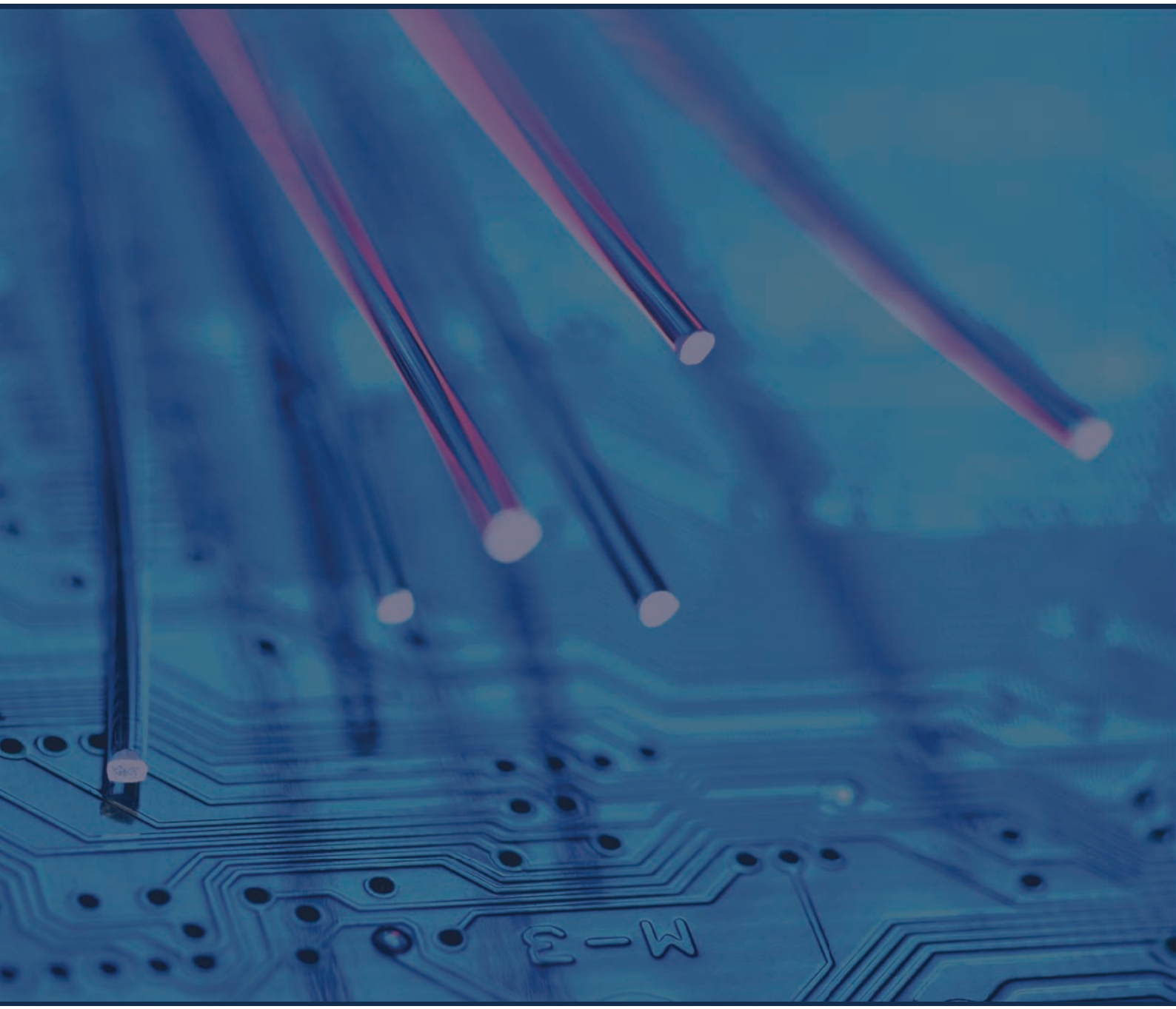


ERICs: CROSS-DISCIPLINARY KNOWLEDGE AND INNOVATION HUBS

The launch of the ERIC organisational form has been an unprecedented commitment by the EU, in the integration of the research and innovation area in response to scientific and societal challenges, by creating an appropriate legal framework to facilitate their establishment and operation at the level of the Community[9]. At Member State level, as well as at intergovernmental fora such as the Global Science Forum (GSF) and the G7, European policies rely on RIs to boost the international competitiveness of the European Common Market, backed by science, technology and innovation for sustainable growth. The European Strategy Forum on Research Infrastructures (ESFRI), as an important point of reference for RI funding through national and EU schemes, contributes to the alignment of RI decision-making by integrating smart specialisation strategies with national RI roadmap development. The ESFRI Monitoring System and Roadmaps provide the framework for the evaluation and implementation of RIs with the objective to strengthen the scientific integration of Europe through a coherent and strategy-led approach to policy-making and by facilitating multilateral initiatives for the better use and development of research infrastructures at EU and international levels.
ERICs, by definition and nature, cover the full cycle from knowledge production to technological and innovative potential in their scientific domains. They are driven by a broader mission in addition to providing targeted solutions within co-designed and cooperative framework which through scaling-up can respond to an overarching common goal beyond the single missions or even disciplines and knowledge domains to contribute collectively to achieving the SDGs as illustrated by the analysis conducted by the ERIC Forum on the contribution of the ERICs to the Horizon Europe Missions[10].

Whether virtual, single-site or distributed through multiple nodes, RIs develop and provide, through their expertise and equipment, cutting edge technology and services to their users. The technical requirements of RI instruments to explore the frontiers of science far exceed existing commercial tools, positioning RIs on the forefront of technological developments. Collaboration between RIs and their users and partners across networks avoids fragmentation and duplication while contributing to cross-fertilisation and interdisciplinary research. The unique combination of scientific excellence, cutting edge technology and interdisciplinary research partnerships anchored within a loco-regional ecosystem provides the RIs with the capacity to respond rapidly to major global challenges such as the COVID-19 pandemic.
The recent COVID-19 pandemic revealed the strengths and gaps in global research and development. It underscored the pivotal role of robust reactive Research Infrastructure networks capable of bringing together multidisciplinary expertise and technology to provide real-time solutions. This powerful resource nurtured through national and European funding schemes such as the Framework Programmes (FP) is one of the cornerstones of European preparedness and response by providing multiple perspectives for generating unique and creative solutions.

In the following section selected case studies underscore the achievements of RIs either alone or in collaboration as integrated innovation hubs providing urgent real-time or long-term framework solutions across scientific domains. The case studies are preceded by the presentation of the respective RI(s).

9 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009R0723
10 ERIC FORUM position paper: The ERIC Community and the Horizon Europe Mission Areas: bit.ly/30GHBiV

Instruct-ERIC

Instruct-ERIC is the European structural biology research infrastructure, bringing together many of Europe's highest quality instruments, scientific and technical expertise in methods and approaches for the structural characterisation of biological molecules in their cellular context. Instruct supports integration of different structural biology technologies including cutting-edge technologies and its infrastructure advances as new technologies and methods emerge that expand the structural resolution of biological processes.

EU-OPENSCREEN ERIC

EU-OPENSCREEN ERIC operates on a global scale to offer access to academic high-throughput screening facilities and medicinal chemistry groups in member countries.

CASE STUDY 1

Boosting the development of COVID-19 antivirals

Instruct partnered with EU-Openscreen to screen chemical libraries for potential anti-COVD19 therapeutic agents using new high-throughput structural screening methods. The method contributed to a world-wide initiative https://covid.postera.ai/covidMoonshot, a crowdsourced initiative to accelerate the development of a COVID antiviral. Submitted drug designs and experimental data were analysed using public supercomputing power to inspire and design new chemical structures that could optimise target hits identified through the screen.

CASE STUDY 2

Portal for high quality COVID-19 reagents

Instruct developed a new reagent portal to answer the rapid need for high quality COVID-19 reagents which was used to deliver high quality standardised reagents for COVID19 research during 2020 when there was a crucial need for reference materials to accelerate the research. The portal was built on the foundations of the Instruct ARIA system, an infrastructure management system which was purpose built as a flexible and adaptable platform which is in use by several ESFRIs and national infrastructure facilities.

ECRIN-ERIC

The European Clinical Research Infrastructure Network ECRIN-ERIC was designed as a 'Big Science' instrument with the mission to support multinational clinical trials, thus allowing to recruit more patients and to faster deliver robust, statistically powered and generalisable evidence. ECRIN federates and coordinates national networks of clinical trial units providing operational support to multinational trial management. Recent developments in trial methodology, and data generation and management offer new opportunities for scaling-up Europe's clinical research potential.

CASE STUDY 3

Accelerating clinical research on COVID-19 through platform trials

In response to the COVID19 outbreak, ECRIN contributed to the development, coordination and implementation of Pan-European multi-arm adaptive 'platform' trials, sharing a single master protocol and the control arm to simultaneously test multiple treatment options for repurposing marketed drugs, to develop innovative treatments, or to test vaccines. This experience and learnings allow ECRIN to support platform trials in other medical fields whenever multiple treatments have to be evaluated and compared in a given disease condition.

Mufid Majnun - Unsplash

The pivotal role played by RIs at the interface of users and developers leads to the provision of unique cross-disciplinary skillsets, deep knowledge repositories as well as the opportunity for developing quality standards and sharing of good practices to optimise resources and research capacities.

Euro-BioImaging ERIC

Euro-BioImaging ERIC, is the Pan-European Research Infrastructure for biological and biomedical imaging, that offers open access to cutting-edge biological and biomedical imaging technologies, training and data services. It enables advanced research in areas such as cancer, neurodegenerative or infectious diseases - expediting the understanding of the biological processes underlying health and disease and supporting drug discovery. Euro-BioImaging also drives scientific progress in areas such as plant and marine biology - providing key insights in the behavior of ecosystems under stress or in changing conditions, such as the ones associated with climate change.

CASE STUDY 4
Access to Life Science RIs interdisciplinary services

In the course of the CORBEL project (H2020 GA N. 654248), Euro-BioImaging co-led the first launch and set-up of open calls for multidisciplinary research projects, through which researchers could access a combination of the services and technologies offered by different ESFRI Life Science RIs. This paved the way for the establishment of a number of service pipelines across diverse RIs, enabling cutting-edge interdisciplinary research of broad impact in a streamlined fashion. The projects supported through CORBEL with access to multiple RIs highlighted the multiplicative effect of joining service offers in different fields, particularly for the implementation of truly cutting-edge research and has been replicated in several other scenarios since.

CASE STUDY 5
Centralised scientific image data archive

In close collaboration with Euro-BioImaging, the centralised image data services via the BioImage Archive at EMBL facilitates access to scientific image datasets linked to a publication or to public studies from basic to preclinical research, enabling the implementation of FAIR principles for key research image data. The BioImage Archive can be used for consultation purposes and to develop new tools, for reuse and re-analysis of existing data sets. The establishment of a centralised repository represents a breakthrough for the scientific community and offers the opportunity to connect image data to other data modalities, allowing cross-domain research and synergies, such as connecting image data and sequence data in the COVID-19 Data portal.

BBMRI-ERIC

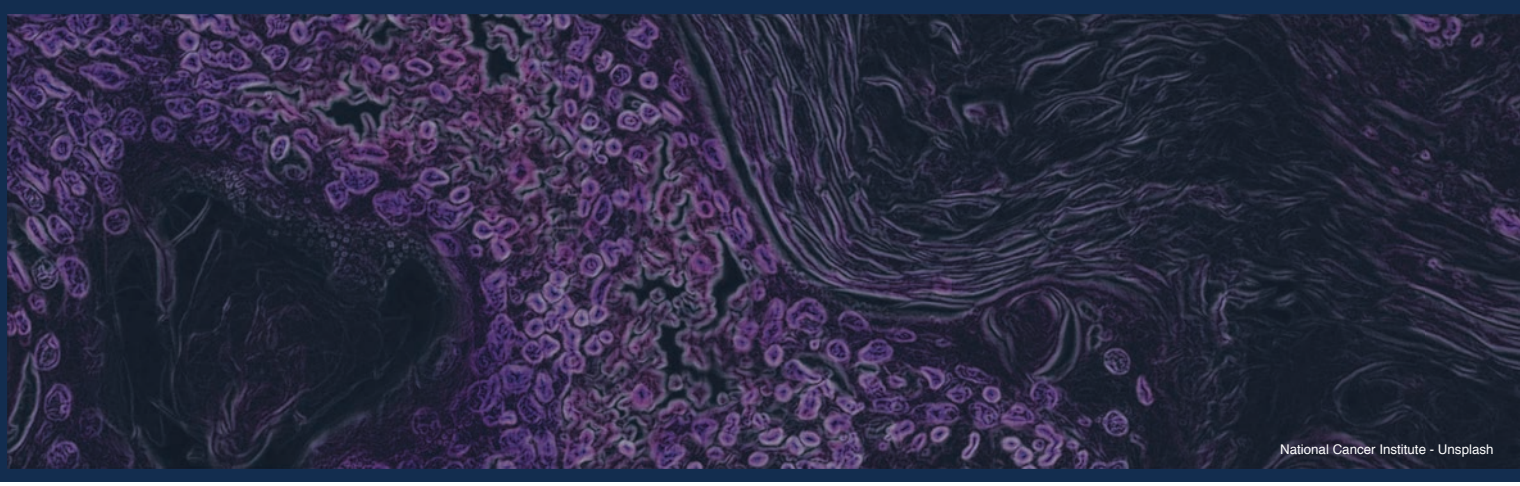
BBMRI-ERIC is a European research infrastructure for biobanking that brings together all the main players from the biobanking field – researchers, biobankers, Industry, and patients – to boost biomedical research.

CASE STUDY 6
Linking researchers to samples across the globe

BBMRI-ERIC Negotiator is a Service that provides an efficient communication platform for biobankers and researchers requesting samples and/or data. It substantially simplifies the communication steps that are necessary to obtain information on the availability of relevant samples/data, particularly if the researchers need to communicate with multiple candidate biobanks. The Negotiator 2.0 is connected to the already established BBMRI-ERIC Directory, the biggest biobanking catalogue on the globe.

CASE STUDY 7
Facilitating the secondary use of clinical trial patient level data and metadata

Clinical trial data produces large datasets for patient stratification and promotes reproducibility (re-analyses) and evidence synthesis (meta-analyses) that helps to optimise the scientific output of clinical research. ECRIN implements the clinical research metadata repository crmdr.org and a patient-level clinical trial data repository allowing GDPR-compliant data sharing for COVID-19 trials. Data generation and quality control is a major cost driver in clinical trials and data reuse from electronic health records and databases or from cohorts and registries, can be transformative. ECRIN is working to lower the cost and facilitate data collection in trials, which is expected to dramatically increase the amount of evidence generated and ultimately benefit the health systems.



National Cancer Institute - Unsplash

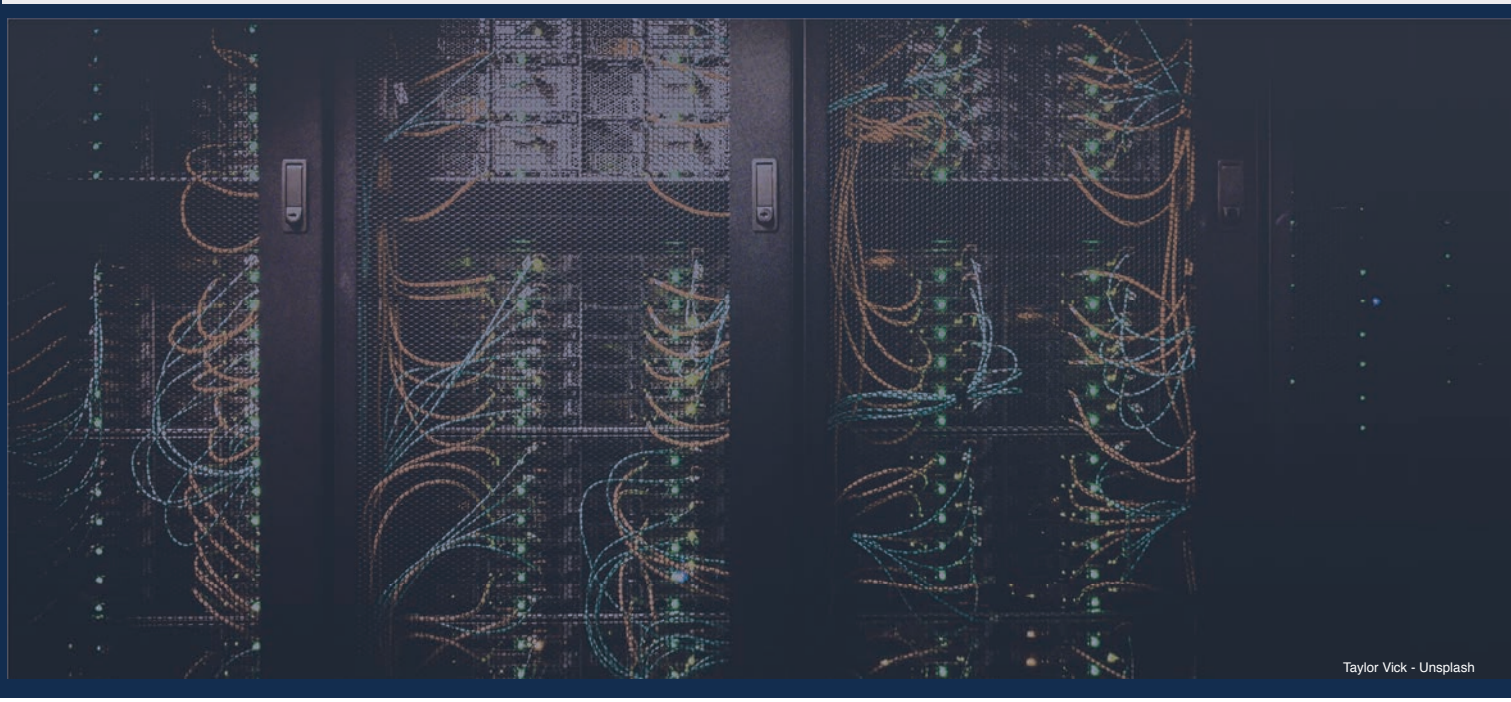
CESSDA-ERIC

The Consortium of Social Science Data Archives provides a full-scale sustainable research infrastructure enabling effective solutions to the major challenges facing society today and improving skills in the social sciences. CESSDA is a leader in social sciences and humanities data discovery across Europe.

CASE STUDY 8
Bringing together trusted Social Science Data Repositories

CESSDA brings together trusted social science data repositories, aiming at full European coverage, with tools and services available to data producers and data reusers. CESSDA provides access to social science data and metadata through the CESSDA Data Catalogue, promoting FAIR principles and interoperability with the European Open Science Cloud (EOSC). The CESSDA DC™ has over 35 000 datasets on various social sciences topics, searchable and documented in numerous European languages with rich metadata that facilitates cross-disciplinary research, all from a single access point. The DC™ ensures that quality data is more accessible and usable by a wide range of users, academic, non-academic, policy makers, not just in Europe but all over the world.

CESSDA and its national Service Providers CESSDA have embraced the many challenges of the global COVID-19 pandemic and its significant societal and health-related impacts. All COVID-19-related metadata is harvested to the CESSDA Data Catalogue as they become available to CESSDA Service Providers.



Taylor Vick - Unsplash

EPOS-ERIC

The European Plate Observing System, is a multidisciplinary, distributed European Research Infrastructure that enables the integrated use of data, data products, and research facilities from the solid Earth science community in Europe. EPOS-ERIC is based in Italy and joined by fourteen European countries. The EPOS mission is to establish and underpin a sustainable and long-term access to solid Earth science data and services integrating diverse European Research Infrastructures under a common federated framework. EPOS is composed of a variety of Earth Science stakeholders that together work for the integration of European Earth Science National Research Infrastructures into a single interoperable platform. EPOS will develop implementation plans and use new e-science opportunities to monitor and understand the dynamic and complex solid Earth system.

CASE STUDY 9

Sharing multidisciplinary solid Earth sciences data

The research community included in EPOS represents over 140 research organisations, as well as about 250 national RIs in Europe, covering ten different disciplines in solid Earth sciences. Since 2007, the EPOS research community has designed a federated framework that takes into account technical, governance, legal, and financial aspects for the establishment of a comprehensive and sustainable multidisciplinary research platform for Earth sciences in Europe.

EPOS is currently in the transition from the implementation phase to the operational phase. Two major achievements to date are, on the one hand, the organisation of domain-specific research communities as Thematic Core Services, with a common approach to data integration and governance; and the development of the e-infrastructure (Integrated Core Services, ICS-C), whereby FAIR data across multiple domains can be explored and accessed to by users. The establishment of a centralised platform for integrated data is unique in the solid Earth sciences domain, and represents an opportunity for broadening the range of users of solid Earth sciences in Europe.

EMPHASIS

EMPHASIS is the European Research Infrastructure of plant phenotyping, providing services supporting sustainable intensification of crop production to ensure the volume and quality of biomass for nutrition and Industry considering changing climate conditions. EMPHASIS addresses sustainable and improved crop production in different, current and future, agro-climatic scenarios, helping to translate high-throughput genotypic analysis of crop variants to high-throughput and high-resolution phenotyping in order to identify high-yield crop varieties for defined environmental conditions.

CASE STUDY 10

Pipeline from data acquisition to data reuse for European plant phenotyping

EMPHASIS aims to integrate the Pan-European instrumented, often unique, plant phenotyping facilities under controlled and field conditions to be able to test a diversity of crop genotypes under current and future agro-climatic scenarios. The facilities will implement high quality experimental standards leading to the acquisition of high quality phenotypic data. This will be complemented by building and integrating compatible, consistent information systems linked into a Pan-European information system, based on established community standards, providing interoperable and re-usable data, which are relevant beyond the plant science community. EMPHASIS collaborates with ELIXIR and other RIs in the context of EOSC-Life to enable data integration across communities.

Markus Spiske - Unsplash

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ERICs: DRIVERS OF EUROPEAN RESEARCH EXCELLENCE, INTEGRATION AND COMPETITIVENESS

RIs are important for their contribution both to the Excellence of European science and innovation as well as for the integration of the European Research Area given their multinational scope. They act as catalysts for economic growth by promoting innovation, supplying high-quality employment and implementing trans-national cooperation. They provide a backbone for innovation by involving not only scientific and technological communities of practice, but also decision makers and the civil society. At the regional level, local industries and stakeholders benefit from the proximity and privileged access to Research Infrastructures which boost local innovation and confer competitive advantage. In addition to the technological collaborations with public and private sectors and the related knowledge transfer, in many cases the construction of the infrastructure itself provides the opportunity for local industry to work on the technological development of the facility. RIs thus generate a significant local socio-economic impact across a range of constituencies and, as such, provide an incentive for regions to attract RIs in their territory, or to invest in them financially.

Solution-oriented research builds on fundamental upstream research carried out in academia, and thus has to be embedded in a multi-domain research landscape and broader funding structures. Such cross-domain collaboration, beyond distinct disciplines and between science and policy, impacting society, is possible in concrete terms through ERICs.

Each RI contributes to fostering and supporting excellence in science, emerging technologies and providing the growth of the innovation-driven economy, encouraging solution-oriented research in its disciplines and knowledge domains. RIs can affect intersectoral collaboration, drawing paths to support regional knowledge-based growth, strengthen synergies, and, ideally, monitor them. The contribution of the RIs in increasing territorial development and sustainability is feasible starting from the optimisation and valorisation of its nodes. The bottom-up approach implies strengthening the nodes (mainly within distributed RIs) and the scientific and technological network at Member State levels, attracting new research and funding partners and triggering spillover effects within their ecosystem.

The multidisciplinary collaborations of ERICs, within their multinational networks, with academia, Industry, and the civil society contribute to increased awareness regarding scientific and societal challenges as well as the provision of tools and methods for tackling them. Novel knowledge, skills, tools and expertise are developed or sharpened to address bottlenecks in research and development with ripple effects at different levels including capacity building.

ESS-ERIC

The European Social Survey ESS ERIC is a research infrastructure in the social sciences and humanities domain, established as an ERIC in 2013. The ESS carries out academic cross-national, cross-sectional surveys of social attitudes and behaviors every two years in up to 37 participating countries since 2002. The results of nearly half a million hour-long interviews are freely available for non-commercial use and available from its Archive. To date the number of registered data users with the ESS ERIC Archive is over 180 and the analysis of data usage indicates that there are nearly 5,500 academic publications using ESS data.

ICOS-ERIC

The Integrated Carbon Observation System, ICOS provides standardised and open data from more than 140 measurement stations across 13 European countries. The stations observe greenhouse gas concentrations in the atmosphere as well as carbon fluxes between the atmosphere, the land surface and the oceans. Thus, ICOS is rooted in three domains: Atmosphere, Ecosystem and Ocean.
The ICOS community consists of more than 500 scientists in both its current Member and Observer countries and beyond. More than 80 renowned universities or institutes are a part of the ICOS community. The ICOS community has strong connections to researchers and operators outside ICOS. ICOS-based knowledge supports policy- and decision-making to combat climate change and its impacts.

CASE STUDY 11

Cross-domain collaboration: Joining forces to monitor urban greenhouse gas emissions

The level of greenhouse gases in the atmosphere rises constantly, heating up our planet. Observing the levels of greenhouse gas emissions is essential to predict climate change and mitigate its consequences. ESS and Integrated Carbon Observation System ICOS ERIC – as part of a new H2020 award ESS ERIC is supporting ICOS ERIC in their new H2020 project. The project - Pilot Application in Urban Landscapes - towards integrated city observatories for greenhouse gases (PAUL) - will provide a concept for monitoring greenhouse gas observations.
Coordinated by ICOS, the PAUL project brings together and evaluates the most innovative measurement approaches of greenhouse gas emissions in urban areas and will develop useful tools and services for cities to support their local climate action plans. To test the feasibility of different modelling approaches in different areas, three cities of different size have been selected as pilots: Paris (large), Munich (medium) and Zürich (small). As part of PAUL, the ESS will develop the methodology for an online questionnaire that will collect survey data measuring public opinion regarding climate change policies at the city level. The ESS will then plan and operate a four-wave survey with a gross sample of 2,500 respondents in two of the pilot cities: Paris and Munich. This is the first time ESS ERIC

has cooperated with an ERIC outside of the SSH domain on a substantive topic.
ESS ERIC is expected to sign an MoU with the other Social Science and humanities Research Infrastructures (SHARE ERIC, CLARIN ERIC, CESSDA ERIC AND DARIAH ERIC) to continue the collaboration after the end of the SSHOC cluster project related to the building of the EOSC. This will facilitate future cooperation.

CASE STUDY 12
ERICs as catalysts for strengthening the European Research Area

European Social Survey and European Values Study

The European Values Study (EVS) is a large-scale, cross-national, cross-sectional survey research programme on basic human values. It provides insights into the ideas, beliefs, preferences, attitudes, values and opinions of citizens all over Europe. The European Values Study covers a wide range of human values. The main topics concern family, work, environment, perceptions of life, politics and society, religion and morality, national identity. As part of the ESS-SUSTAIN-2 H2020 grant, ESS ERIC is exploring a future partnership with the EVS which may lead to an EVS module in the ESS as a special rotating module as well as well as cooperation in other areas such as training. Work on developing such a module is underway as are data comparisons between the ESS and the EVS data time series.


Jason Blackeye - Unsplash

1. Building leading-edge capacity through training, access to cutting-edge services, and mobility

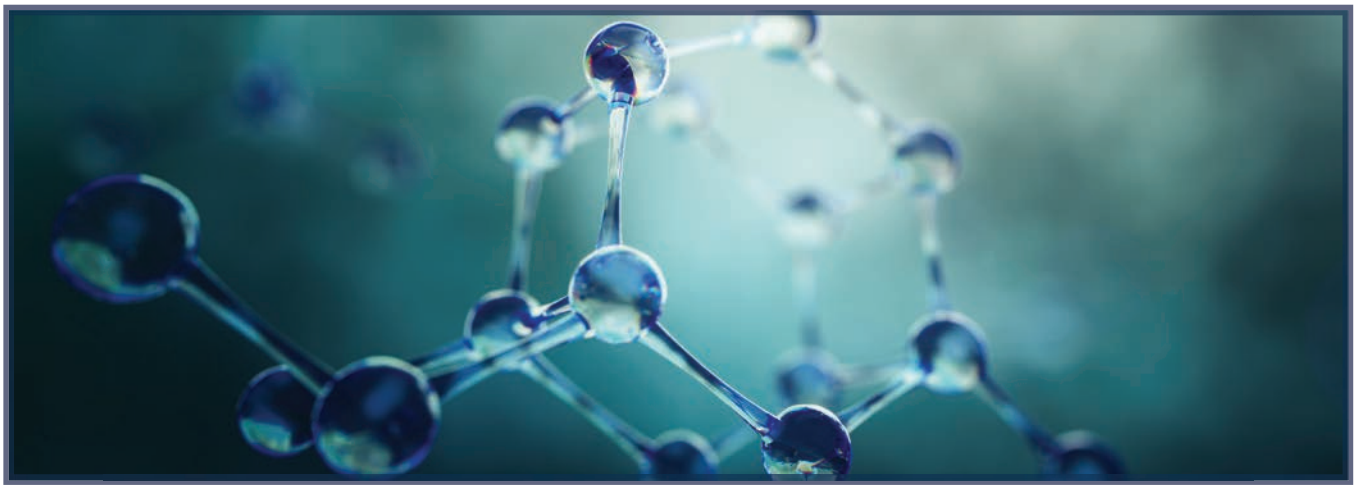
Training and access to cutting-edge facilities

Research infrastructures are, in addition to their cutting-edge services and equipment, repositories of knowledge, skills and expertise. In ERICs the added value of regional and/or international cooperation in the context of service to users offers great opportunities to foster knowledge transfer and human capacity building.

There are several ways in which this is achieved:

- Hands-on training of users that visit the ERIC hub, any of its nodes or its associated service facilities,
- Training events (schools, workshops, courses, webinars, etc.) coordinated by the ERIC, and in synergy with the needs of users of other ERICs,
- Staff exchange, in short or long visits to the ERIC hub or among the nodes,
- Facilitating the development and dissemination of high-quality manuals and online tools, available through the ERIC website.

The above-mentioned activities are organised by the ERIC, often with support from European Transnational Access (TNA) programs that act as a catalyser, providing “seed money” and motivation. The European contracts also set the grounds for stronger collaboration among partners. Thematic RI clusters such as the European Environmental Research Infrastructures (ENVRI) and European Life Science Research Infrastructures (LSRI) also provide powerful collaborative platforms for training, sharing knowledge, tools and best practice and to ensure the interoperability and optimal use of resources. Some RIs have training as one of their objectives and dedicate substantial resources to it, independently of the availability of project funding.



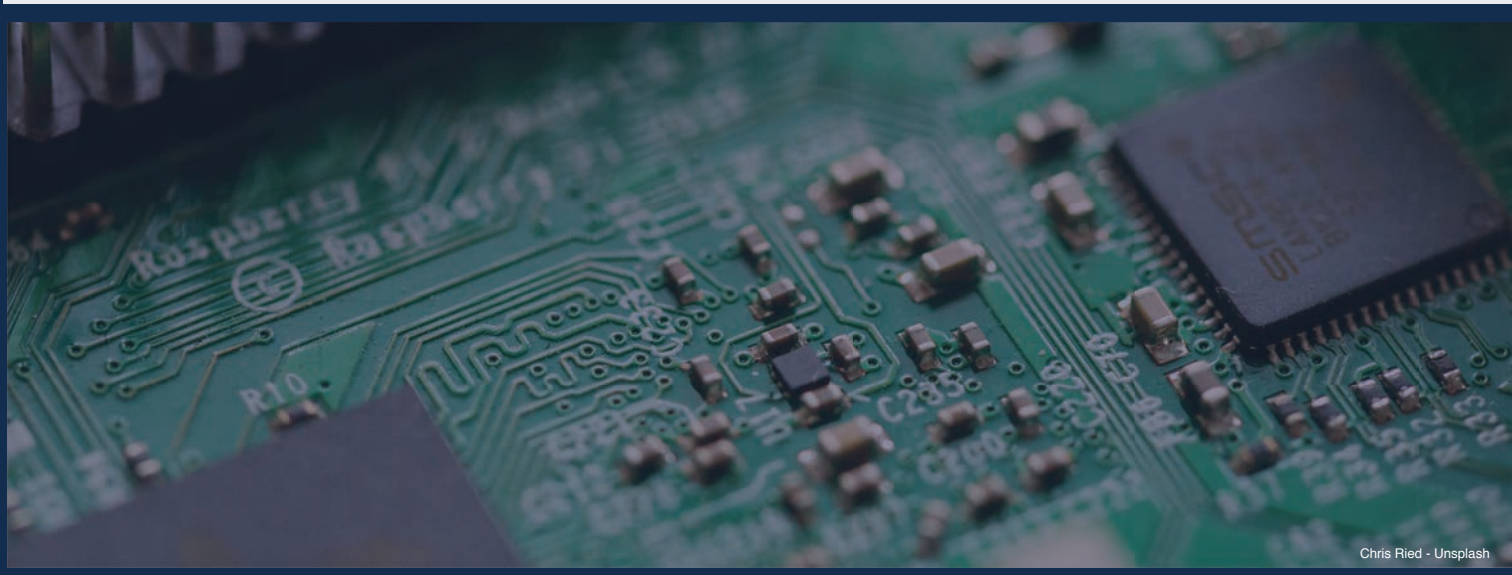
CERIC-ERIC

CERIC-ERIC is a research infrastructure integrating and providing open access to some of the best facilities in Europe with particular focus on facilities in Central-Eastern Europe, such as the ones based on photon, neutron and ion-beam sources, NMR and electron microscopy, to enable advanced characterisation of materials, biomaterials and nanotechnology in these countries. CERIC offers free and open access by quality selection to global research community, thus attracting world level researchers and supporting the internationalisation of the research groups operating in these facilities.

In response to the growing environmental and health challenges, CERIC has selected the fields of energy and life science as its key priorities and is developing targeted services to address the challenges in these fields and increase capacities through its investments in research infrastructure, joint research and PhD programmes.

CASE STUDY 13
Building capacities across EU and its neighborhood through training

CERIC is a RI offering merit-based access to advanced material characterisation techniques. These techniques are not common in EU's Eastern neighborhood, and difficult access to them would result in limited applications and low success rates from less RD&I-intensive countries. To overcome this and contribute to bridging the R&I gap, CERIC runs training courses dedicated to research communities in these countries while supporting the access costs. Within its EU-supported project ACCELERATE, it has also created an outpost in Ukraine. These activities have resulted in significant increase in the number of users' proposals from these countries and their success rate over the past 5-year period.



Chris Ried - Unsplash

ERICs include the support to the users of their facilities in their mission. The researchers cannot be expected to be experts in each technique or in the use of the instrumentation required to produce their science. This support has to be guaranteed by adequate resources. It is demonstrated that expert support provided to the users of Research Infrastructures increases the chances that they will consider including the RI in their studies. Since ERICs offer access through open calls, in which the proposals are evaluated and selected only by considering the scientific quality and technical feasibility, the ERIC must be ready to provide extensive support in the preparation, execution, and analysis of the research program, including physical visits to the ERIC sites when necessary. On the other hand, successful applicants to ERIC access programs should get recognition and support from their own institutions and national programs, providing complementary resources to those offered by the ERIC.

ERICs can facilitate cross-disciplinary research by the arrangement of procedures that allow the continuation of approved studies also in other facilities. The users then get advice and are guided through that process. This can include, but is not limited to, access to online resources such as archives or databases.

Training events coordinated by the ERIC optimise the preparation efforts for a maximum impact. Introductory schools to the ERIC field of expertise, organised at the ERIC premises (hub or nodes) but also online, allow to increase the awareness of potential users and also the networking among them and with the experts, and their engagement into the community.

An important added value is that the course material prepared can be translated to the local language by the ERIC nodes, increasing the accessibility by removing the language barrier.

A good example is the “Iniciativa VLBI IberoAmericana” (IVIA), which uses the know-how of JIVE ERIC and partners to create training possibilities in Spanish that can be easily accessed by the growing communities of radio astronomers in Latin America. Another example is the training pilot service provided by EMPHASIS, which targets researchers and technicians from academia and Industry, including early-career researchers, PhD students, hardware and software engineers, technology developers and end-users (e.g. farmers and agronomists) by providing individualised training measures, but also by coordinating training activities together with neighbouring research infrastructures.

More focused workshops or webinars are also organised by ERICs, and kept available in a repository for future access after the event.

Mobility

Several of the Research Infrastructures support mobility of the users, in order to perform experiments, thus contributing to the mobility within the ERA. In addition, staff exchange, during short or long visits to the ERIC hub or any of the nodes, has the obvious advantage of ensuring hands-on work with the experts. It also promotes networking and engagement. When the visit is consequence of user support, as mentioned above, it provides complementary valuable information from the user to the ERIC staff regarding their needs and expectations, which serves to improve not only the support but also the services that the ERIC provides. Last, but not least, communication is essential to guarantee that human capacity building reaches all potential users, taking special care of diversity in a very proactive way.

CASE STUDY 14
Global BioImaging Training

The European RI Euro-BioImaging is one of the founding members of the international network of imaging infrastructures and communities called Global BioImaging. Global BioImaging today comprises 11 partners representing national or regional imaging infrastructures and communities all bound by an umbrella MoU: Euro-BioImaging ERIC, Japan's Advanced Bioimaging Support, Microscopy Australia, Australia's National Imaging Facility, Mexico's National Laboratory for Advanced Microscopy, South Africa BioImaging, India BioImaging Consortium, Singapore Microscopy Infrastructure Network, BioImaging North America, Canada BioImaging and Latin America Bioimaging. Global BioImaging (GBI) was initiated in December 2015 by an H2020 international cooperation grant, awarded to Euro-BioImaging. The grant allowed the nascent infrastructure to strengthen its fledgling bonds with partners in Argentina, Australia, India, Japan, South Africa and the USA and build a sustainable framework for international cooperation. The international relationships deepened over time, with more and more partners coming on board. The project evolved into an actual international network of research infrastructures and communities, which currently enjoys generous support by the Chan Zuckerberg Initiative, which finances many of its activities, particularly for capacity building of imaging infrastructure staff.

In practice, Global BioImaging organises:

- Annual international workshops called "Exchange of Experience" to learn from leaders around the globe in infrastructure operation and management, research policies, technology trends and the latest developments in bioimaging worldwide.
- Focused meetings and working groups to discuss specific subjects of interest to the international bioimaging community, build international collaborations and publish international recommendations.
- A comprehensive training program, composed of webinars, online and in person courses as well as an online resource to support the professional development of managerial and technical staff working in bioimaging Research Infrastructures and facilities.
- A staff exchange program (called Job Shadowing) to allow imaging facility staff to learn from leading international peers on-the-job, by visiting selected facilities and shadow expert personnel in their daily work.

The Global BioImaging coordination, hosted by the intergovernmental organisation EMBL, also plays a key advocacy role for bioimaging worldwide: it supports the GBI partners to build a strong case "at home" (i.e. towards local funders) that imaging technologies are key in the advancement of life sciences and therefore require adequate infrastructure investments.

2. Knowledge transfer spillovers: collaborations with universities, SMEs and civil society

Industry collaborates with RIs as service developer and user providing employment opportunities which may lead to developing new capacities. Furthermore, collaboration with RIs gives industrial and civil society partners access to cutting edge technologies for solving challenges they face at local and/or global level.

European Spallation Source-ERIC

The European Spallation Source ESS-ERIC is a multi-disciplinary research facility based on the world's most powerful neutron source currently under construction on the outskirts of Lund in southern Sweden. ESS is one of the largest science and technology infrastructure projects being built today. The facility's unique capabilities will both greatly exceed and complement those of today's leading neutron sources, enabling new opportunities for researchers across the spectrum of scientific discovery, including materials and life sciences, energy, environmental technology, cultural heritage and fundamental physics and addressing some of the most important societal challenges of our time.

CASE STUDY 15

In-kind concept collaboration at the heart of the ESS: Target Wheel

At the core of the ESS facility in Sweden stands the target wheel where spallation neutrons will be generated. The target wheel is a 2.6 m diameter stainless steel disk containing bricks of a neutron-rich heavy metal: tungsten. It weighs almost five tons. The wheel rotates at 23.3 RPMs, in time with the arrival of the proton beam painted across the exterior of the wheel shroud. The unit is cooled by a flowing helium gas system interfaced with a secondary water system. The tungsten wheel is a new technology for spallation sources, none of the established target designs being adequate for the higher power level of ESS. The design of the target system components has a direct impact on the number of neutrons that can be generated, and is therefore of utmost importance for the future scientific capabilities of the ESS facility.

ESS Bilbao in Spain is responsible for this in-kind delivery and is an internationally renowned strategic center for neutron technologies. The ESS Bilbao Consortium is run by two public administrations. On one side, there is the Spanish State Government, with a 64% stake, and on the other, the Government of the Basque Autonomous Region, with a 34% stake.

The workforce at ESS Bilbao is made up of around 60 highly qualified experts in the fields of physics and engineering. The organisational structure of the ESS Bilbao Consortium is broken down into topic-based groups, each with its own specific work projects. The particular added value that ESS Bilbao offers to the society around it is the knowledge that it generates in the accelerator, target and neutron generation fields.

ECCSEL-ERIC

The European Research Infrastructure Consortium for CO2 capture ECCSEL ERIC enables open access to a world class research infrastructure in Europe for carbon capture, transport, storage and utilisation (CCUS) researchers and Industry across the world. ECCSEL facilitates and coordinates requests for access to facilities within the ECCSEL Research Infrastructure. The mission of ECCSEL is to reach out to relevant Industry and research communities to determine their needs in terms of research infrastructure in order to enable full-scale deployment of CCUS in Europe. The ECCSEL Consortium currently consist of five European countries.

CASE STUDY 16

Enabling zero CO_2 emissions

ECCSEL is a distributed research infrastructure with 20 nodes in the consortium. ECCSEL ERIC consist of over 80 research facilities and continues to grow. Currently, ECCSEL is in a transition phase from solely offering the service of open access to research facilities, to a more advanced level of services. This is done mainly through the ECCSELERATE project, where a central activity is increased Industry collaboration in order to step up the services offered to Industry and research communities. The expansion of these focus areas is expected to contribute to the overall vision of ECCSEL enabling low to zero CO2 emissions from Industry and power generation through research that will provide cost effective CO2 capture, transport, storage and utilisation technologies.

ECCSEL ERIC is advancing in the central focus of collaboration with Industry through Horizon Europe Pillar 2 engagement. The launch of the Partnerships Processes4Planet, Clean Steel Partnership and Clean Energy Transition Partnership constitute arenas for expanded use of the ECCSEL Infrastructure. Working in close connection with the Strategic Research and Innovation Agendas of the European Partnerships ensures that ECCSEL ERIC maintains the right research priorities towards our research facilities. Likewise, research priorities deriving from the ECCSEL community are also used as input for coming Work Programmes in Horizon Europe.

LifeWatch ERIC

LifeWatch ERIC is the e-Science European Research Infrastructure for Biodiversity and Ecosystem Research, a distributed Research e-Infrastructure to advance biodiversity research and to provide major contributions in addressing the big environmental challenges, such as the impact of climate change on Earth biodiversity and ecosystem functioning. This goal is achieved by providing access through a single infrastructure to a multitude of sets of data, e-services and tools enabling the construction and operation of Virtual Research Environments (VREs), which allow the accelerated capture of data with new innovative technologies and knowledge-based decision making-support for the management of biodiversity and ecosystems.

CASE STUDY 17

Co-creation with civil society: Agroecology living labs

LifeWatch ERIC is to date the unique ERIC involved in the co-design and establishment of a partnership aimed to accelerate the transition towards sustainable, climate and ecosystem-friendly farming practices by enabling to better grasp short to long-term agroecological processes from farm to landscape levels, by boosting place-based innovation in co-creative environments ensuring farmers and other key stakeholders' engagement (including consumers) and by improving the flow and uptake of knowledge and innovations on agroecology across Europe.

3. EU research innovation, competitiveness and sustainability

RIs contribute to structuring the European Research Area by participating in ambitious Pan-European crosscutting thematic networks expanding thus their reach and impact across sectors to bridge knowledge gaps and strengthen collaborations to address scientific challenges that need to be undertaken at the global scale.

JIVE-ERIC

The Joint Institute for Very Long Baseline Interferometry (VLBI) JIVE ERIC is the central organisation in the European VLBI Network (EVN) that supports the operations of the EVN as a facility and implements the core data processing and user services that are essential to turn the network of distributed telescopes into a single observatory to study the radio sky at the highest possible resolution. JIVE ERIC serves as a catalyser for a broad range of research and development activities in VLBI-related fields, creating new value and exploiting capabilities that would not be possible by individual partners.

CASE STUDY 18

Deciphering global radiodata in real-time

The EU FP7 eInfrastructure project NEXPReS, coordinated by JIVE ERIC, allowed the introduction of a real time (e-VLBI) component to every experiment, aiming for enhanced robustness, flexibility and sensitivity, boosting the scientific capability of this distributed facility and offering better data quality and deeper images of the radio sky to a larger number of astronomers. NEXPReS developed high-speed recording hardware, as well as software systems that manage the process and hide all complexity. Real-time computing in a shared infrastructure and dynamic bandwidth and high-capacity networked storage on demand was also addressed to improve the continuous usage of the network and prepare the EVN for the higher bandwidths to ensure it remains the most sensitive VLBI array in the world.

Currently, the e-EVN is still the only VLBI network in the world capable of real time observations, and provides enhanced scientific performance for all users of the EVN and its partners.

EMSO-ERIC

The European Multidisciplinary Seafloor and water column Observatory EMSO is a distributed European Research Infrastructure based on an integrated system of regional facilities. It is aimed at the long-term multidisciplinary observation of the seafloor and the water-column by means of multi-sensor platforms deployed in scientifically relevant key sites of the European seas. EMSO's main scientific objective is the observation and recording of biogeochemical, and physical variables, at an unprecedented resolution, with the ultimate goal to understand the complex interactions between the geosphere, the biosphere, the hydrosphere and the atmosphere to address the main environmental challenges affecting the Earth System like climate change, biodiversity and marine ecosystems and geo-hazards.

CASE STUDY 19

Continuous-time monitoring of the ocean to decipher environmental patterns

X_EMSO provides continuous time-series multidisciplinary data, going from the sea surface to the deep seabed, and sub-seafloor to address many key processes that affect the entire ocean. The volume of data and information provided by EMSO ERIC allows the description of processes ranging from extreme episodic events to slow trends, difficult to distinguish from the underlying variability of short-term processes. The continuous, high-resolution, long-time-series collection of multiple variables at chosen fixed sites across a breadth of environments pursued by EMSO, allows the development of new approaches to shed light on the complexities of the Earth System.

Spacex - Unsplash

AnaEE

Analysis and Experimentation on Ecosystems AnaEE is the European Research Infrastructure that brings together state-of-the-art experimental and analytical platforms for ecosystem research throughout Europe. By linking these platforms for modelling approaches, AnaEE advances our understanding of the environmental impacts of ongoing global change, and fosters adaptation and mitigation strategies for safeguarding ecosystem services, as well as their societal and economic benefits. This has an impact on agriculture, management of forests, and also on evidence-based policies.

CASE STUDY 20
Fostering the functions and services of Ecosystems in the Anthropocene

Ecosystems services are crucial for food security, human health, and welfare. It is essential to keep their functions active to face the challenges of the Anthropocene, such as biodiversity conservation, greenhouse gas reduction, carbon sequestration, ensuring drinking water quality and quantity, and food production. Experimentation and modelling are of uttermost importance to understand the functioning of ecosystems and their behavior under anthropogenic pressures such as climate change, pollution, land use and management practices. New management practices and evidence-based policies for adaptation and mitigating the negative impacts, can be proposed and tested thanks to modelling and experimentation under realistic conditions, simulating various possible global change scenarios.

CASE STUDY 21
Blockchain technology to mitigate climate change impact on ecosystems and biodiversity

Counteracting the climate change-induced loss of biodiversity and the accelerating rate of species extinctions is a global-priority. The negative impact of alien species invasion on ecosystem integrity is well documented, affecting both the structural and functional properties of ecosystems, such as native species abundance and range, native population space use, behaviour and energetics, community composition and diversity, ecosystem processes and functioning and ecosystem services.

LifeWatch ERIC is Europe's first line of response to this emergency, applying and advancing ICT technologies, web networks, interconnecting scientific communities and research centres internationally into its web-based research infrastructure. This has been achieved through the launch of an Internal Joint Initiative on Non-endemic and Invasive Species (IJI-NIS acronym), with the main pilot study cases engaged in the corresponding Tesseract Virtual Research Environment, jointly with the associated LifeBlock-chain and other applications.

LifeBlock is the Blockchain platform design, constructed and deployed by LifeWatch ERIC to provide “anti-tampering” provenance, and traceability

e-Services by also guaranteeing the availability of FAIR compliant resources: data and software, but also publications and media. LifeBlock stores, manages and gives access to a variety of data and ecosystem applications addressed to all types of organisations and communities of practice. It is a network which can scale autonomously and independently without the need of any central control body, due to the characteristics of distributed databases of Blockchain architectures. Additionally, a token management mechanism has been implemented based on Smart Contracts applications, so that the associated tools for aggregation/access/data management are in the public domain.

CASE STUDY 22
Clinical Research Initiative for Global Health

CRIGH Clinical Research Initiative for Global Health: ECRIN supports multinational clinical trials in Europe where a favourable ecosystem enables cooperation (partial regulatory and ethical harmonisation, availability of funding for multinational trials etc.). However, there is a real need for global cooperation, in particular for trials on rare diseases, or during health outbreaks as illustrated by the COVID crisis. ECRIN therefore contributed to the launch in 2017 of the CRIGH including more than 40 global partners with the objective of developing common tools, practice and training and to facilitate global health cooperation.

Julia Koblitz - Unsplash

4. Bridging funding schemes towards sustainability

As reported in the ERIC Forum Policy brief on Funding models for access to ERIC multinational / transnational services[11]: over the course of the past decade funding from diverse schemes, together with the invaluable contributions of ERIC member countries, have allowed ERICS to deliver access to services, facilities, samples and data across Europe. A continuous and open dialogue between ERICs and all funding bodies is required to identify and adopt solutions that will lead to the optimised and sustained use of ERICs. The collaboration between the EU Commission and the Member States in the continued evolution of the ERIC Regulation is also required to define and optimise the funding volume and mechanisms supporting the broad variety of ERIC operations models. A sustained effort from ERICs in their evaluation and assessment of their funding models will contribute to a fruitful and productive dialogue. A dedicated working group within the ERIC Forum continues to study these questions and reflect on pragmatic solutions.

CASE STUDY 23
Mobilising European Regional Development Funds (ERDF) for ERICs

The Spanish government allocated 51,2 M€ ERDF[12] funds to the Andalusia Region. As a consequence, the total budget allocated to actions, as co-financed by the 80%-20% co-funding rule, for activities related to LifeWatch ERIC is 64 M€. Specifically, this fund should be used between 2020 and 2023.

The most innovative aspect of this call is that it ensures the use of funds for internationalisation purposes channeled through an ERIC. In this call, at least, 36% of the overall project budget must be allocated to the Internationalisation of RD&I activities developed and/or carried out by LifeWatch ERIC in collaboration with other Research Infrastructures (other ERICs, EOSC, Copernicus, etc.)[13].

Several projects have been submitted in response to this call. The start of the selected projects was planned to start in May 2020. Nevertheless, the implementation is suffering a reasonable delay due to COVID-19. In any case, these funds have been properly approved, upgraded and put in relation with the pandemic[14], so that these projects have been recently started.

In a similar way, CERIC's facilities have benefited from the ERDF funds 2021-2027 in Slovenia, Czechia, Croatia, Poland, Italy and Austria. Investments of national, ERDF and Horizon 2020 funds towards the same objective of enabling transnational access to research infrastructure and building of capacities at EU level demonstrates well the contribution of ERICs to the development of ERA.

11 ERIC Forum Policy Brief Funding Models for Access to ERIC Multinational/ Transnational Services https://www.eric-forum.eu/wp-content/uploads/2020/09/ERIC-Forum_Policy-Brief.pdf
12 European Regional Development Fund https://ec.europa.eu/regional_policy/en/funding/erdf/
13 1st Technical and Innovation Report: Creating synergies between ERICs and the (Regional) Research and Innovation Strategies for Smart Specialisation -RIS3 ADD LINK
14 https://www.ciencia.gob.es/stfls/MICINN/Ministerio/FICHEROS/Plan_de_choque_para_la_Ciencia_y_la_Innovacion.pdf, see page 19.

CASE STUDY 24
EPOS Sustainability Project

EPOS is currently working on implementing four main areas to achieve the final goal of moving from financial viability to long-term sustainability (EPOS Sustainability Project[15]):

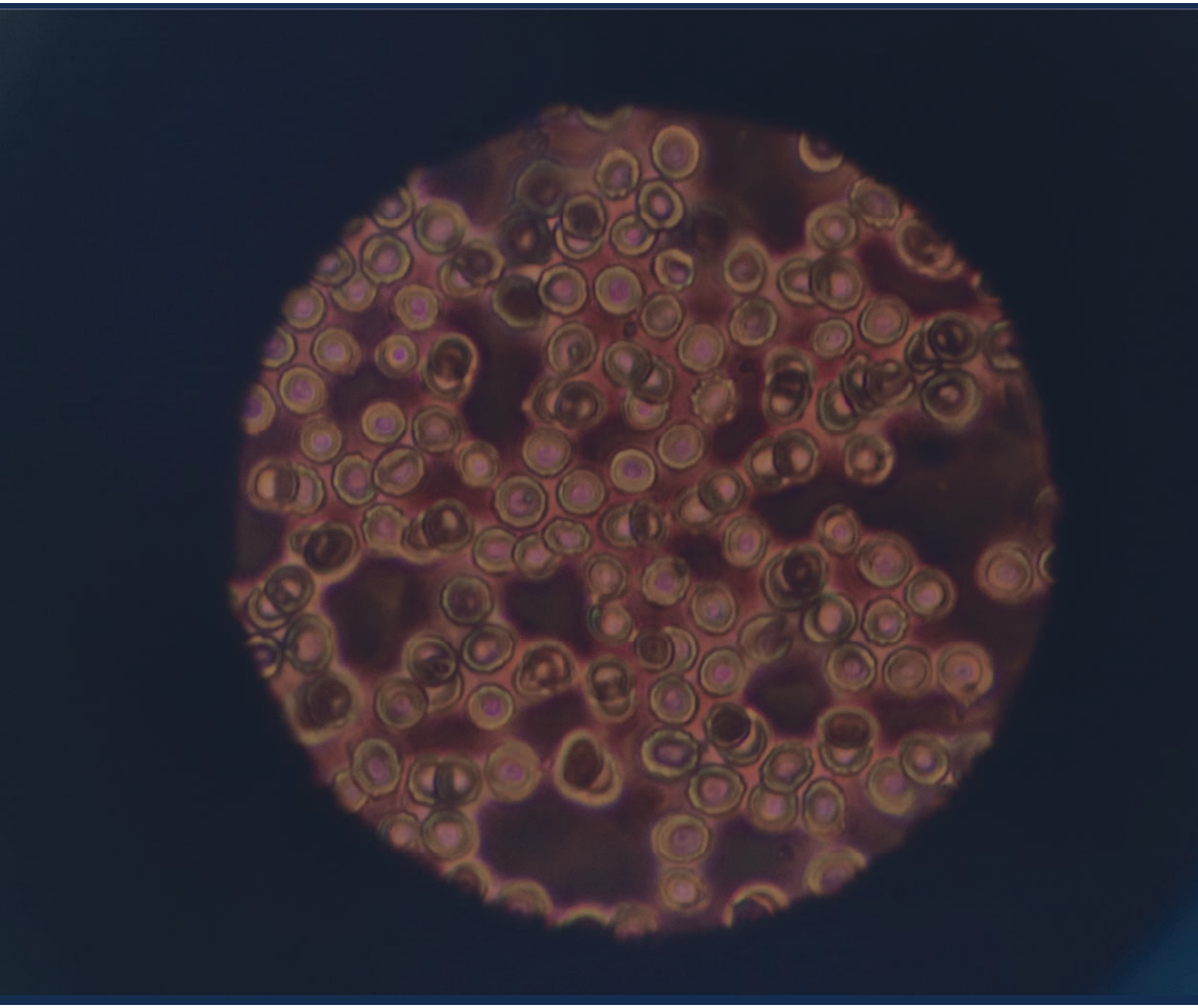
1. Financial, dedicated to strengthen financial sustainability, through the consolidation of EPOS ERIC memberships, the engagement of new countries in EPOS and the harmoniation of EPOS data and service provision with national strategies and funding.

2. Technical and Innovation, by securing sustainable data and service provision within the EPOS Delivery Framework, by contributing to the sustainable operation of the EPOS e-infrastructure, and by fostering innovation for the implementation and use of the EPOS e-infrastructure.

3. Excellence, through the cooperation of EPOS with similar worldwide initiatives on interoperability of geoscience data; through international cooperation to foster the multidisciplinary use of solid Earth science data; through user engagement to create awareness on multidisciplinary data and services accessible through EPOS; and through user training initiatives describing the available services in EPOS to create awareness on the potentiality of solid Earth science data to answer ground-breaking scientific questions.

4. Economic and Societal, by defining a sustainable, ethically coherent way to provide services and scientific information to society; by implementing a strategy for socio-economic impact assessment and for a sustainable cooperation with the private sector.

15 The EPOS SP (Sustainability Phase) project that has been funded by the EU Horizon 2020 under Grant Agreement no. 871121 to perform activities aimed at ensuring the long-term sustainability of the EPOS Research Infrastructure as the Europe's key Research Infrastructures for the Solid Earth Science.



CONCLUSIONS AND CHALLENGES

The diversity of the RI landscape, the differences in size, scope and activities underscore the integration endeavors undertaken at multiple levels by the RI community with their national and European stakeholders to highlight their common challenges and shared interest in overcoming them. Targeted hands-on guidelines, toolkits and recommendations developed within RIs and with different stakeholders provide insight into the needs of European RIs in order to flourish and the required next steps. The following hurdles have been identified for the successful upscaling of Big Science through ERICs within the current landscape and need to be addressed collectively:

1. Visibility of the ERIC

Visibility of ERICs needs to be improved, both at the Member States' (policy makers, funding agencies) and also researchers' level. Proper acknowledgement of the ERIC in the research results and publications is required, to help demonstrate the impact of the ERIC. It will be beneficial to create outreach material for the ERIC nodes, also in the local language. Proactive awareness of the editors of scientific journals may help ensuring that the ERICs are also properly recognised.

2. Competition between the ERIC and partners

In cases where the ERIC can develop activities or projects which are of interest to individual partner facilities, conflicts of interest may arise. The partner could force the ERIC to avoid the competition, which may compromise the interests of other partners.
This may affect especially small partners/countries, which may not have sufficient own infrastructures to become a prominent beneficiary and depend much more on the ERIC to develop the activity. The EC could mediate in such cases, if this capacity is included in the ERIC Regulation. Another possibility is that ERICs regulate the participation to projects in their agreements with the partners and Representative Entities, especially in cases where the ERIC is better positioned to be a beneficiary because several of its facilities can contribute to the action.

3. Lack of RI recognition as stakeholder

The Member State that hosts an ERIC, within the premises of its national RI, may not have developed the procedure to separate both with sufficient clarity. Consequently, the ERIC may be then perceived locally as a "department" of the national RI node. Moreover, there are signals that explicit visualisation of the members may prevent the sense of integration (e.g. flags). The ERIC added-value must be known and recognised by the partners, to better engage their sense of belonging and ownership, and the EC must continue supporting the effort of integration (as with the INFRADEV[16] calls), while being vigilant to ensure that all the partners respect the ERIC entities.

16 https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2021-2022/wp-3-research-infrastructures_horizon-2021-2022_en.pdf

4. Member States support for RI: Access to national funding streams

While recognising that ERICs have as per the ERIC Regulation the capacity to act in the Member States, their current eligibility to access competitive calls for national or regional funding is very diverse. There may be reluctance in some Member States who believe that allowing ERICs to present projects may increase the competition for the limited funds. It is however important to note that the participation of the ERIC either alone or via the national nodes could improve the quality of the project. The national rules for eligibility should accept the ERICs, which would be beneficiary only if applying to the calls in coordination with the national RI[17].

5. Inclusion in European Research funding schemes

The ERICs are mainly supported by the Member States, however the EC must also maintain its role beyond the preparation phase, e.g. through the INFRADEV contracts, demonstrating interest, supporting sustainability and protection of the international collaboration. Currently, the great majority of the calls for proposals targeting Research Infrastructures in Horizon Europe address groups of RIs and the integration of their services to contribute to solving grand challenges such as cancer, infectious diseases or transition towards a sustainable agroecology. In further support for the implementation and sustainability of these initiatives, creating productive cross-linkages, especially through different domains should be taken into consideration and strengthened. In addition, and complementary, in order to fully reap the benefits of the investments in RIs, support to curiosity-driven research should continue to be provided via grants to individual RIs (e.g. via INFRADEV calls).

6. Legal constraints

Non-EU countries in order to become full members in an ERIC need to accept the ERIC Regulation, which impose some conditions that may not be accepted (e.g. the recognition of the EU Court of Justice). This is difficult to avoid, however, it is possible to engage in an ERIC in different forms, like participation regulated by a MoU, which could set a favorable context for the collaboration.

7. Collaborations with Industry and SMEs

Companies collaborate with ERICs as users, suppliers and co-creators, benefitting from the expertise, technology development and access to an unprecedented large network of researchers. Access to the RI sophisticated expertise and instrumentation, usually at lower cost than through commercial services, particularly enhances the competitiveness of SMEs with limited capital funding. An ERIC may create an “Industry board” and employ a dedicated Industry contact officer to support continuous engagement with Industry, organise joint events, increase visibility of the RI or support commercial users of RI services. Certain RIs already have a formal Industry Board established, which strengthens the link between technology developers and users and provides feedback to the RI on Industry-relevant topics and technological trends from an Industry perspective. In addition, by creating a “ERIC label”, Industry could highlight collaborations to increase visibility and grow the reputation of both companies and RIs.

17 ERIC Forum Policy Brief Funding Models for Access to ERIC Multinational/ Transnational Services https://www.eric-forum.eu/wp-content/uploads/2020/09/ERIC-Forum_Policy-Brief.pdf

8. Sustainability of RIs

The necessity of pursuing long-term sustainability calls for constant revision of an ERIC Business Plan and risk management. Sustainability is conditioned by multiple facets (legal, governance, technical, scientific, financial) and by multiple stakeholders (users, national RIs, governing boards, policy makers, funders), all of them influencing the capacity of an ERIC to remain sustainable in time. This is particularly challenging in the case of distributed Research Infrastructures, where the number and diversity of contributors requires a high level of coordination and synchronisation of policies and resources.

9. Translation of science results in policies

The impact of research performed thanks to ERICs is often of societal and economic nature. Examples are numerous such as ecosystems and biodiversity conservation, climate change, clinical research, sociology, agronomy, etc. ERICs have a broad view on the individual research project performed on their premises, often of European nature crossing the national boundaries. Therefore, they are the actors of choice to write synthesis of the results with impact to the society at large, and they can provide advice to the regulators and policy-makers. Given the interdisciplinary nature of the major scientific and societal challenges such as climate and biodiversity, or human-virus interaction and ecosystems, the cooperation between ERICs is needed.

RECOMMENDATIONS

The main challenges identified to unlock the potential of ERICs as Big Science enablers are both material and intangible and thus require a multipronged approach for optimising the research ecosystem to facilitate knowledge transfer and operational implementation, to boost competitiveness and support the upscaling of projects to tackle pressing global societal challenges. The following recommendations summarise the points raised and illustrated through the case studies presented in this policy brief.

1. The added value of Pan-European Research Infrastructures as Big Science instruments should be further underscored among the research community and key stakeholders including the Industry at national and international levels. Global expansion and partnerships with ERICs should be promoted to foster collaborations in global research projects to tackle shared challenges. Moreover, the participation of third-countries in ERICs, if not endorsing the ERIC Regulation, should be encouraged by other different forms, such as participation as strategic partners regulated by a MoU, which could set a favourable context for the collaboration.

2. The benefit of joining and/or collaborating with an ERIC should be manifest when individual partners engage in projects or activities in which they have interest, in order to use the joint capabilities and create synergies. Large-scale interdisciplinary collaboration across RIs and scientific communities mobilising collective intelligence not only benefit the participating entities but promote excellence and greater impact by the prioritisation of research questions and the collaborative design of research protocols.

- Authorship rules, evaluation criteria and career development policies should be developed to promote the participation of research and infrastructure staff in highly collaborative competitive projects.
- The operational and legislative frameworks for data standards, sharing, reuse and analysis should be strengthened.

3. Member State support for ERICs should be promoted in competitive funding calls in the framework of national programs, supporting the national nodes and hubs and increasing the quality and impact of the proposed activities. The national rules for eligibility should be adapted to allow the participation of ERICs as beneficiaries (for example, they could be beneficiary by applying to the calls through the national nodes or through the seat). ERICs in any Member State, independently of the details of the hosting arrangements, must be clearly recognised as a distinct, international, established institution with its own legal entity as per the ERIC Regulation, including the national ERIC nodes and hubs. The EC must be vigilant to ensure that all the Members States recognise the ERIC entities.

4. Funding mechanisms should be adapted to unfold the full potential of ERICs to meet the needs of large science projects in terms of volume and multinational and cross-border availability, as well as prioritisation criteria in order to fully benefit from the ERIC infrastructure support.

5. ERICs are valuable to Industry. The visibility of these collaborations can be promoted by creating an "ERIC label" that Industry can exploit as a label of excellence. Setting-up an "Industry board" can contribute to maintaining and strengthening collaborations.

6. The EC must maintain its role and support ERICs beyond the preparation phase, through instruments such as the INFRADEV contracts and promoting their participation in all the pillars of the EU Framework Programme, to support and facilitate the international collaboration.

7. Evidence-based policy-making should be supported by strengthening the dialogue between ERICs and policy-makers through dedicated fora to promote regular formal and informal communication.

APPENDIX

ABBREVIATIONS USED

DG AGRI: Directorate General for Agriculture
DG RTD: DG for Research and Innovation
EC: European Commission
ENVRI: Environmental Research Infrastructures
EOSC: European Open Science Cloud
ERA: European Research Area
ERDF: European Regional Development Fund
ERIC: European Research Infrastructure Consortium
ESFRI: European Strategy Forum on Research Infrastructures
FAIR: Findability, Accessibility, Interoperability, and Reusability
INFRADEV calls: Research Infrastructures work programme under Horizon Europe
JRC: Joint Research Center
LSRI: Life Sciences Research Infrastructures
MS: Member State
RD&I: Research, Development and Innovation
RI: Research Infrastructures

ERIC FORUM

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Contact:

info@eric-forum.eu

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