ELIXIR's Long-term sustainability plan (2023)

Purpose of this plan

The aim of ELIXIR's Long-term Sustainability Plan is to set out short and long-term actions in order to support the sustainability of ELIXIR's activities, particularly ELIXIR Nodes and the services they run. There are over 400 services run by ELIXIR Nodes and this plan is not intended to act as or replace the need for those services to develop their own sustainability planning. Rather, the document focuses on high-level activities that can best support the long-term sustainability of ELIXIR as a whole, i.e. its capacity to maintain its activities over the long term.

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Setting the scene

ELIXIR: the research infrastructure for biological data

ELIXIR unites Europe's leading life science organisations in managing and safeguarding the increasing volume of data being generated by publicly funded research. As a distributed research infrastructure, ELIXIR coordinates, integrates and sustains bioinformatics resources across its membership, and enables users in academia and industry, regardless of geographic location, to freely access services that are vital for their work.

ELIXIR is an intergovernmental organisation of 21 Member States, plus the European Molecular Biology Laboratory (EMBL), and two Observer countries. It is a distributed infrastructure, with a Hub acting as the coordination secretariat, national Nodes in each of the member countries, plus the European Bioinformatics Institute (EMBL-EBI), which is also an ELIXIR Node.

How ELIXIR is funded

As a distributed infrastructure, ELIXIR has very mixed sources of financing, mostly public by nature (Figure 1).

The ELIXIR Hub is funded through contributions (i.e. membership fees) paid by member countries, and much of this funding is transferred back to ELIXIR Nodes to implement the activities of ELIXIR's five-year Scientific Programme[1]. Specifically, this is via a range of ELIXIR-funded internal projects[2] that connect[3] national bioinformatics infrastructures and their experts with each other.

ELIXIR Nodes, which run the services that users access, are typically funded through national-level sources of financing that support national coordination activities within the Nodes. The development and operation of services is usually funded through national grants, sometimes through dedicated infrastructure grants, but more frequently through competitive research grants where service development/operation is one component. Some ELIXIR Nodes also receive support from international funders (such as the US National Institute of Health, NIH) and foundations (such as the Wellcome Trust and Wallenberg Foundation). A small number of ELIXIR Nodes receive income from industry, though the volume of this is modest compared to the public funding they receive.

Collectively[4] (and also separately), the ELIXIR Hub and Nodes access EU grant funding (where eligible), particularly from Horizon Europe, and through other related programmes such as the Digital Europe programme and Partnerships such as the Innovative Health Initiative. Finally, some ELIXIR Nodes also access EU Structural Funds to support national coordination and the purchasing of facilities and technologies.

[1] https://www.elixir-europe.org/about-us/what-we-do/elixir-programme
[2] https://elixir-europe.org/internal-projects
[3] https://elixir-europe.org/about-us/impact/node-interactions
[4] EU projects awarded in the name of ELIXIR https://www.elixir-europe.org/about-us/how-funded/eu-projects

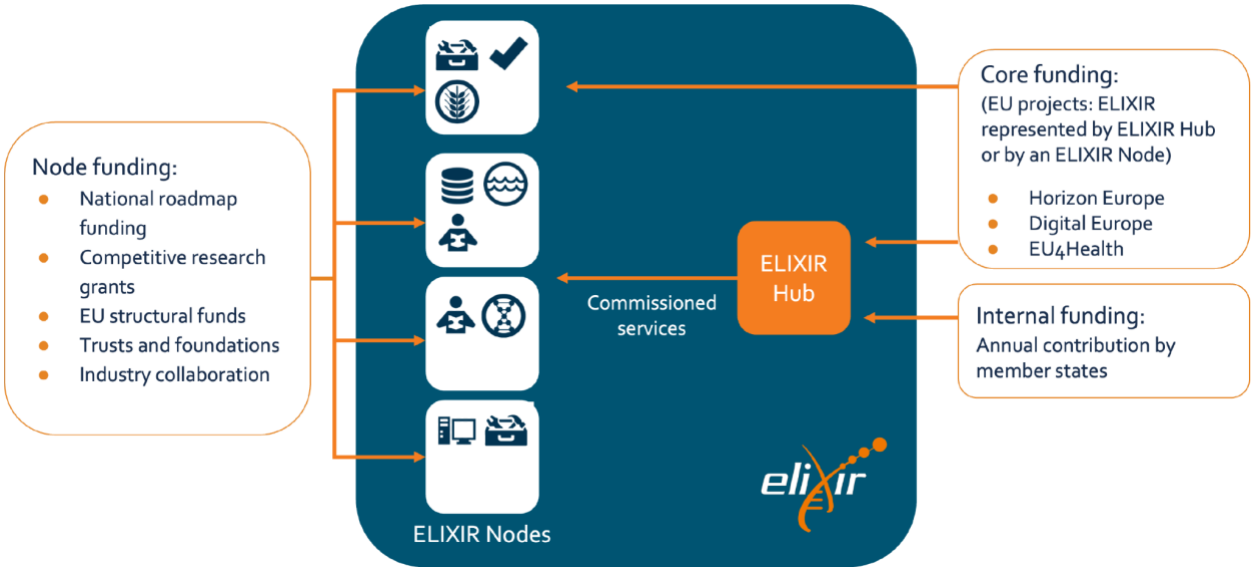

Figure 1. ELIXIR is funded via a range of mostly public sources.

ELIXIR brings together more than 220 institutes across Europe, in which only a fraction of activities relate to ELIXIR, so summing up the totality of costs of all ELIXIR activities in each country is extremely complex and not completely accurate. To give an idea of scale, however, ELIXIR's Financial Plan[5] for 2019-2023 included €35 million from Member State contributions, plus external grants from the European Union in which both the ELIXIR Hub and Nodes are beneficiary. The figure excludes national-level sources of financing for the ELIXIR Nodes (e.g. related to their core funding if any, national-level funding awards such as national roadmaps for research infrastructures, EU Structural Funds, EU grants not coordinated by the ELIXIR Hub, etc).

Over the years, ELIXIR has been remarkably successful in securing EU funding[6] - this success rate (close to 90% currently) is due to a range of factors such as operating world-class services and underlying infrastructure, collectively preparing strong funding proposals, along with carefully and strategically selecting opportunities where ELIXIR's chances of success are high. Strategically important grants that ELIXIR has been awarded include Beyond 1 Million Genomes[7] (€4 million), BY-COVID (€12 million), ELIXIR-CONVERGE (€9.8 million), ELIXIR-EXCELERATE[8] (€19 million), EOSC-Life[9] (€26 million euros) and Genomics Data Infrastructure (€40 million including co-financing from partners)[10].

[5] ELIXIR's Financial Plan for 2019-2023 https://drive.google.com/file/d/12fc9xD1ldQgsdBzk-pqVAFplMdOx8RwH/view
[6] https://elixir-europe.org/about-us/how-funded/eu-projects
[7] https://b1mg-project.eu/
[8] https://elixir-europe.org/about-us/how-funded/eu-projects/excelerate
[9] https://www.eosc-life.eu/
[10] https://gdi.onemilliongenomes.eu/

Bioinformatics resources are a public good

As a public-funded research infrastructure, ELIXIR was built on and operates based on the principles of Open Science. It works to ensure that bioinformatics resources remain a 'public good' that is as open and free to users as possible. Bioinformatics resources often require long maturity periods, multiple interdisciplinary breakthroughs, and/or simultaneous technology developments. These are undeniably costly to the public purse, yet the return on investment is extremely favourable when considering socio-economic and societal benefits. For instance, public repositories prevent the creation of private silos and large-scale "information asymmetry", which are known to restrict useful innovation. Public biological data resources are indeed used in the development of commercial applications[11,12] (e.g. in the health, food production and environment sectors), and for creating employment and tax revenues in the process. More generally, free and open access to publicly funded bioinformatics resources has been shown to foster research efficiency and increased productivity, for instance through better information and knowledge discoverability and accessibility, along with promoting "economies of scales"[13]. When it comes to databases, creating multiple monopolies would be less efficient as researchers would spend time and effort merging similar data together, if they can even afford to pay for the subscriptions to several competing databases.

An exception to the principle of free access includes some computing and cloud services[14], which are depletable resources and operate on a cost-recovery model, based on the user's location and field (academic, industry). Yet, non-depletable resources (such as data, tools and software, and standards) that have been developed, and/or are operated using public funding, should be provided to users without charge[15].

The need for a Long-term Sustainability Plan

The current funding landscape presents challenges in supporting bioinformatics resources, and life science services more generally. There are thousands of bioinformatics services worldwide[16] and most agree that there is no straightforward solution to their long-term survival[17]. Most funding schemes from national and European funders typically provide fixed duration and competitive research grants. As a result, very few bioinformatics resources have secure, long-term funding[18].

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[11] http://f1000research.com/articles/5-160/v1

[12] https://f1000research.com/documents/7-590

[13] https://www.embl.org/documents/wp-content/uploads/2022/05/EMBL-EBI-highlights-2021-digital.pdf

[14] Examples of Compute services: https://www.elixir-europe.org/services/tag/compute

[15] https://f1000research.com/documents/9-65

[16] https://bigd.big.ac.cn/databasecommons, https://www.frontiersin.org/articles/10.3389/frma.2018.00018/full

[17] https://datascience.codata.org/article/10.5334/dsj-2020-008/, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2948195/

[18] https://academic.oup.com/bioinformatics/article/36/8/2636/5709034 (figure 6)

There are very few national or international funding organisations that have dedicated, bespoke funding schemes to support the long-term sustainability of research infrastructures, including databases, software, tools, standards, ontologies, training materials and cloud computing. In particular, it is the maintenance of bioinformatics infrastructure that is notoriously hard to fund, in contrast to 'exciting new research projects'[19]. Even if a given bioinformatics resource benefits from secure, long-term funding, it can nevertheless be directly impacted by the funding issues of resources it depends on, since it is common that bioinformatics resources are closely interlinked and interdependent with data, information and knowledge flowing from one to another[20]. Perhaps paradoxically, the cost-savings and increased efficiencies provided by common international databases and interoperable database ecosystems, further exacerbate sustainability issues since the "death" of a database can create a gap in an interconnected landscape and affect its functioning. Finally, whilst funders increasingly recommend that data are deposited in certain repositories[21], e.g. to encourage cost-savings via data reusability, it can well happen that the recommended deposition database itself runs out of funding before the end of the funded data depositing project. Beyond databases, similar challenges affect other types of bioinformatics resources such as software, standards and workflows.

Finally, many services are also part-funded through institutional contributions. This is a particular challenge for universities that naturally see teaching and research as higher priorities for institutional support than providing free access to services to users across the globe. On-going efforts to reform research assessment[22] may help improve this through a better recognition of the diverse outputs, practices and activities that maximise the quality and impact of research.

Implementing ELIXIR's Long-term Sustainability Plan

This Long-term Sustainability Plan builds upon an earlier version (2019)[23] structured around a set of recommendations elaborated by an ELIXIR Working Group[24]. This 2023 update is now structured around the recommendations of the Long-Term Sustainability Working Group of the European Strategy Forum for Research Infrastructures (ESFRI), as presented in its 'Long-Term Sustainability of Research Infrastructures' document[25]:

[19] https://www.nature.com/articles/4351010a

[20] E.g. see Figure 3 of https://academic.oup.com/nar/article/44/D1/D20/2503123, and figure 4 in https://academic.oup.com/bioinformatics/article/36/8/2636/5709034

[21] Both Horizon Europe and the European Research Council recommend ELIXIR services to their grantees

[22] https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/reforming-research-assessment-agreement-now-final-2022-07-20_en

[23] ELIXIR's Long-term Sustainability Plan https://f1000research.com/documents/8-1642

[24] Position Paper from the Working Group for the Long Term Sustainability of ELIXIR Resources (2015) https://drive.google.com/file/d/0BzkGGa8FI4XuakprTTc4amJCS1k/view

[25] https://www.esfri.eu/sites/default/files/u4/ESFRI_SCRIPTA_VOL2_web.pdf (page 10)

1. ***Establish and maintain excellence*** *through the entire lifecycle of RIs by all appropriate means, by securing adequate framework conditions, and by opening the RIs up to the world,*
2. ***Ensure that research infrastructures have the right people in the right place at the right time****, by strengthening and harmonising national research and educational systems to make sure that all essential skills are available,*
3. *Harmonise and* ***integrate a vision for convergent operation of research infrastructures and e-Infrastructures*** *in Europe to ensure cost-effective service provision to the user communities,*
4. ***Fully exploit the potential of research infrastructures as innovation hubs*** *by incorporating strategies for their development into national and European innovation policies,*
5. *Set up effective means of* ***determining the economic and wider social value of research infrastructures*** *and incorporate these benefits into science-policy-society dialogues,*
6. *Establish adequate framework conditions for* ***effective governance and sustainable long-term funding for research infrastructures*** *at every stage in their lifecycle, together with effective management,*
7. *Foster broader* ***coordination at National and European levels****, when designing processes for planning and supporting national and pan European RIs and so enhance their strategic value.*

These recommendations are analogous to those presented in the European Commission Staff Working Document on the long-term sustainability of research infrastructures[26]. The following sections and tables summarise, for each ESFRI recommendation, the actions that are or will be carried out by ELIXIR to address them, and therefore support the long-term sustainability of ELIXIR overall.

Recommendation 1: Establish and maintain excellence through the entire lifecycle of RIs by all appropriate means, by securing adequate framework conditions, and by opening the RIs up to the world

Unlike many other infrastructures, especially those with a physical setting such as telescopes and particle accelerators, users do not need to apply nor register to use the majority of ELIXIR's

[26] https://op.europa.eu/en/publication-detail/-/publication/16ab984e-b543-11e7-837e-01aa75ed71a1/language-en (page 9)

resources. Hence there is no 'excellence-based' review of user applications, and users across the world typically need only an internet connection and the right technical skills.

ELIXIR's resources are used by scientists in industry and academia, and play a key role in knowledge generation in the life sciences. It is imperative, therefore, that these resources are of high quality, robust, and relevant, in order for them to support scientific discovery. The resources themselves should be excellent, and they should enable excellent science. Having excellent resources does not in itself guarantee secure funding, but running services that are recognised by the scientific community to be of poor quality or reliability, or of limited use, greatly reduces the likelihood of securing all forms of funding.

Actions of relevance to Recommendation 1: 'Establish and maintain excellence'.

Action	Notes
Develop and maintain benchmarks of quality and excellence in ELIXIR resources such as Core Data Resources (CDRs), ELIXIR Deposition Databases (EDDs) and Recommended Interoperability Resources (RIRs)	Sustainability work on CDRs taken forward by ELIXIR's engagement in the Global Biodata Coalition.
Periodic reviews of ELIXIR Nodes and ELIXIR Programme by ELIXIR's Scientific Advisory Board	Regular reviews carried out of ELIXIR Nodes and ELIXIR's Scientific Programme. Sharing of reports and recommendations so that they can be addressed.
Ensuring quality of ELIXIR's internal activities	Providing a framework for monitoring and quality assurance of internally coordinated activities and related outputs (e.g. Commissioned Services), in order to assess: a) compliance with ELIXIR rules and procedures and b) progress towards the set strategic goals over a Programme period and across all areas of activities. The monitoring framework should provide data-driven input into future investments (both internally and externally).
Establishment of monitoring of service usage for key resources	Participation in ESFRI monitoring exercise will include indicators for service usage. Specific indicators and services to be identified
Develop recommendations on best practice for service development	Maintain a web page highlighting guidance and best practice[27]
Enable connections between Nodes through ELIXIR-funded Commissioned Services	Demonstrate the transnational connections made through partners participating in Commissioned Services[28]

[27] ELIXIR guidance and best practice in service development: https://elixir-europe.org/what-we-offer/guidelines

[28] ELIXIR Node Connections https://elixir-europe.org/about-us/impact/node-interactions

Recommendation 2: Ensure that research infrastructures have the right people in the right place at the right time, by strengthening and harmonising national research and educational systems to make sure that all essential skills are available

Human capital is a critical component required in operating a world-class, distributed infrastructure - a professional and motivated workforce with a range of skills is needed across the infrastructure as whole. In the case of ELIXIR, the diversity of roles that are required include scientific and technical ones, such as data experts, curators, software engineers, scientific managers and web developers, through to roles that support the administration and professional operation of the infrastructure, including legal experts, project managers, impact evaluators, communications and outreach experts and governance experts to name but a few.

Research infrastructures are not necessarily the most visible or recognised career paths for many individuals. Factors exacerbating the recruitment and retention challenge include a recognised shortage of data scientists and a strong 'pull' factor from industry for technically-focussed roles where remuneration is comparatively more attractive. Therefore, it is critical to ensure that ELIXIR overall is seen as a rewarding opportunity for potential recruits, and that opportunities are provided to existing staff, supporting their training and career development. ELIXIR, therefore, ensures human resources planning and implementation covering expertise in different areas of its activities complementary to the maturity stage of a Landmark RI as well as externally triggered needs (e.g. ESFRI Monitoring and engagement in EOSC activities).

Actions of relevance to Recommendation 2: 'Ensure that research infrastructures have the right people in the right place at the right time'.

Action	Notes
Provide training opportunities for ELIXIR staff in research infrastructure management and operation	ELIXIR is supporting its fifth cohort on the EMMRI Masters qualification[29], and will continue to support staff across ELIXIR benefit from this RI-specific training. A new ELITMa training programme will also provide tailored training to Nodes, based on the EMMRI Masters.
Enable staff and knowledge exchange opportunities for staff in ELIXIR Nodes	Provide dedicated budget and mechanisms for Staff Exchange projects[30] including Travel Grants and Knowledge Exchange Scheme (for ELIXIR-Industry collaboration)

[29] Executive Masters in Management of Research Infrastructures https://emmri.unimib.it

[30] ELIXIR Staff Exchange Programme https://elixir-europe.org/internal-projects/staff-exchange-programme

Provide development opportunities for ELIXIR staff and representatives	This includes opportunities to represent ELIXIR at external events, to lead or co-lead work packages and tasks on ELIXIR-coordinated grants
Develop policies and processes that ensure ELIXIR is a supportive environment for staff and contributors, encouraging diversity	The ELIXIR Hub's Equal Opportunities Strategy and EDI group will remain visible and active and the Code of Conduct for events will be applied in ELIXIR events and open to Nodes to adopt for their own
Support job-seekers and recruiters for data and software roles in the life sciences by making opportunities more visible and easier to find	Promote the ELIXIR vacancy portal[31], increasing the number of vacancies listed and page views
Engage in the discussions and initiatives that give greater career recognition to all aspects of open science careers	Follow developments around the EC-led reforming of research assessment[32] and the EOSC Working Group on recognition and rewards, providing input from across ELIXIR to ensure that all open science skills and careers have more suitable recognition systems

Recommendation 3: Harmonise and integrate a vision for convergent operation of research infrastructures and e-Infrastructures in Europe to ensure cost-effective service provision to the user communities

Research infrastructures are a critical component of an effective open science ecosystem and ELIXIR plays a key role in connecting and supporting the digital-related needs of other ESFRI Landmarks and Projects. ELIXIR is itself a virtual infrastructure that operates in the life science domain. Collaborating with other research infrastructures and e-Infrastructures brings mutual benefits for users, operators and funders. Collaborating with an ESFRI RI allows ELIXIR to understand and better support the data-related needs of that specific community such as structural biology, microbial biotechnology and plant sciences. ESFRIs often provide access to technologies and facilities which generate data that can be stored within ELIXIR, or supported through the development of standards. ELIXIR has or is developing bilateral Collaboration Strategies with BBMRI and EuroBioImaging, and has developed joint activities with EMPHASIS for collaboration on plant science standards development.

ELIXIR works jointly with all of the life science ESFRIs through EU-funded cluster projects including EOSC-life, and previously CORBEL and BioMedBridges, and through other Horizon

[31] ELIXIR's vacancy portal https://elixir-europe.org/about-us/vacancies?field_vacancies_category_tid=1303&field_vacancy_country_tid=All&title=

[32] Process towards an agreement reforming research assessment, EC, 2022 https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/process-towards-agreement-reforming-research-assessment-2022-01-18_en

Europe projects such as BY-COVID, EOSC4Cancer, B1MG and GDI. The European Open Science Cloud currently provides opportunities for ELIXIR to collaborate with other ESFRIs and e-Infrastructures and will continue to be an important vehicle for collaboration going forward.

Collaborations with other research infrastructures and e-Infrastructures often take place nationally, within countries where the local ELIXIR Node may provide dedicated support to other national Nodes of ESFRIs. Indeed, many national ELIXIR Nodes have been developed as joint initiatives of national Nodes for other ESFRIs such as Health RI in the Netherlands.

Actions of relevance to Recommendation 3: 'Harmonise and integrate a vision for convergent operation of research infrastructures and e-Infrastructures'.

Action	Notes
Develop collaborations with key ESFRIs and other relevant infrastructures	Implement Collaboration Strategies[33] with key ESFRIs such as EuroBioImaging and BBMRI, and consider the creation of others when needed
Develop and implement a strategy for ELIXIR to engage effectively in the European Open Science Cloud	ELIXIR's EOSC strategy, version September 2022[34]
Engagement in relevant EU-funded projects that enable collaboration with e-infrastructures	Participate in EU projects with eInfras including EGI, OpenAire, GEANT and EUDAT, in particular topis funded through EOSC-related calls
Engage in relevant community-led and grassroots initiatives	Ensure that experts in ELIXIR can contribute to and shape developments in relevant Europe-level initiatives such as RDA.

Recommendation 4: Fully exploit the potential of research infrastructures as innovation hubs by incorporating strategies for their development into national and European innovation policies

The open innovation ecosystem significantly contributes to tackling the grand challenges in life sciences (e.g. better health, food security). At its heart, we find publicly available life science data resources. The role that open research data plays in stimulating innovation and supporting growth in industry is widely acknowledged by data generators, innovators (Open data driving growth

[33] ELIXIR Collaborations https://elixir-europe.org/collaborations
[34] ELIXIR EOSC Strategy 2022, https://zenodo.org/record/7120997#.YzSNL-zMJMw

ingenuity and innovation[35]) and funders alike (Data Harvest Report[36]). As a publicly-funded infrastructure, ELIXIR makes it easier for researchers and entrepreneurs in academia and industry to find and share data, exchange expertise and agree on best practices that help science move forward and accomplish breakthrough discoveries.

One of the principal ways ELIXIR aims to deliver a return to funders is through the jobs and business development for the ELIXIR user. For example, in an ELIXIR survey of over 50 bioinformatics SMEs, 76% of them stated that without data shared on open repositories, they would not be able to offer their product or service, while 89% said that a product or service has more features because of access to shared or open repositories (Lauer, et al. 2021[37]). Studies on the patterns of citations of life sciences databases have also demonstrated a clear long-term value of open data in industry (Bousfield, et al. 2016[38]). In addition, ELIXIR Nodes are considered hotbeds of collaboration and networking, while ELIXIR training influences career paths, and entrepreneurial actions (Lauer, et al. 2021[39]).

Knowing the high impact of digital infrastructures in the bioinformatics industry evolution, ELIXIR established a portfolio of industry-related activities at the beginning of its existence with the aim to support the creation of an open innovation ecosystem in the life sciences. As part of ELIXIR's Industry Strategy 2019[40], a range of schemes and activities have been established to ensure that activities and services are aligned with the needs of the industry, such as via the Industry Advisory Committee, the ELIXIR Knowledge Exchange Scheme, the Bioinformatics Industry Forum and Innovation and SME Forums. Additionally, several communication activities to keep industry updated on ELIXIR activities, provide input on their needs and develop collaborations and co-development opportunities currently exist and will continue to be developed too.

Actions of relevance to Recommendation 4: 'Fully exploit the potential of research infrastructures as innovation hubs'.

Action	Notes
Operate a portfolio of industry support activities, with oversight from the Industry Advisory Committee	Current portfolio of industry activities[41]

[35] Open data driving growth ingenuity and innovation, Deloitte Analytics Paper, 2012 https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/deloitte-analytics/open-data-driving-growth-ingenuity-and-innovation.pdf

[36] https://rd-alliance.org/sites/default/files/attachment/The%20Data%20Harvest%20Final.pdf

[37] https://f1000research.com/documents/10-828

[38] Patterns of database citation in articles and patents indicate long-term scientific and industry value of biological data resources (2016), D. Bousfield, J. McEntyre, S. Velankar et. al. https://pubmed.ncbi.nlm.nih.gov/27092246/

[39] Open data: A driving force for innovation in the life sciences (2019), https://f1000research.com/documents/10-828

[40] https://f1000research.com/documents/9-215

[41] https://elixir-europe.org/industry

Support capacity building in industry engagement efforts of ELIXIR Nodes via the Innovation and Industry Focus Group	Run Industry and Innovation Focus Group[42] and the ELIXIR Knowledge Exchange Scheme[43] for industry-academia collaboration
Demonstrate how ELIXIR resources support industry and innovation by recording use-cases, good practices and industry-related performance indicators	Continue to promote existing reports that demonstrate industry benefit including 'Public data resources as business model for SMEs'[44], 'Open data: A driving force for innovation in the life sciences[45], and initiate further projects that demonstrate the economic impact of infectious disease open data and open source software

Recommendation 5: Set up effective means of determining the economic and wider social value of research infrastructures and incorporate these benefits into science-policy-society dialogues

Demonstrating the scientific and socio-economic impacts of ELIXIR is central to ensuring the long-term sustainability of its services and coordination activities within each country. As a public-funded infrastructure where ELIXIR Nodes typically provide access to resources free of charge, continuously demonstrating the wider socio-economic value of this is key.

Work under this portfolio is guided by the 2020 recommendations[46] made to ELIXIR by a High-Level Expert Group, which assessed the progress of ESFRI and other world class research infrastructures towards implementation and long-term sustainability. Collecting data and metrics on the economic and societal impact of ELIXIR and its activities is critical - equally as important is ensuring that this impact is communicated to stakeholders and funders, both reactively when funders submit formal requests, and proactively through public impact dashboards and associated communication campaigns.

Actions of relevance to Recommendation 5: 'Set up effective means of determining the economic and wider social value of research infrastructures'.

[42] https://elixir-europe.org/focus-groups/innovation-and-industry

[43] https://elixir-europe.org/industry/knowledge-exchange-scheme

[44] https://f1000research.com/documents/7-590

[45] https://f1000research.com/documents/10-828

[46] Supporting the Transformative Impact of Research Infrastructures on European Research, EC, 2020https://ec.europa.eu/info/publications/supporting-transformative-impact-research-infrastructures-european-research_en (June 2020)

Action	Notes
ELIXIR to maintain a public dashboard[47] to make it easier for funders and other policy stakeholders to grasp the scale of usage of its flagship services, as well as the scientific and socio-economic impacts of ELIXIR-related activities more broadly	Some of the information on the dashboard is meant to be directly relevant to a range of requests for information, which are regularly issued to ELIXIR by national-level funders as well as influential stakeholders such as the European Strategy Forum for Research Infrastructures (ESFRI). Particular attention will be given to flagship ELIXIR services, including service collections (e.g. Core Data Resources) and the ELIXIR-operated Life Science Login. Altogether, the dashboard will aim to present ELIXIR's impact in its best light, through broad-ranging and meaningful evidence (qualitative, quantitative)
Implement a communications strategy based on impact	This will result in an impact-centred communication process to highlight impact in the communications materials about ELIXIR (for example in news releases, the annual report, social media and in presentations); to maximise the benefits of ELIXIR's expertise in measuring impact by sharing outcomes of this work; to increase the impact of ELIXIR through targeted communication campaigns; and to normalise "impact thinking" when planning communications in the Hub and Nodes
ELIXIR to continue maintaining and enriching its performance and impact Toolkit, currently on the Intranet[48], with a plan to make it more publicly-facing in 2023 as part of an ELIXIR-CONVERGE deliverable	The Toolkit aims to help Nodes measure and communicate their performance and impact to national-level and other funders
In collaboration with ELIXIR-CONVERGE, ELIXIR to complete the delivery of a Strategy-driven Implementation Study[49], which is working to further build the capacity of Nodes in performance and impact evaluation	This is done through formal training, knowledge-exchange, and the application of the new skills and knowledge in the context of Nodes' particular needs through case studies
ELIXIR to engage as a funded partner in the PathOS project	The project aims to identify how impact pathways of open science develop as well as recommendations for policy interventions to enable further impacts
The ELIXIR Hub's impact officer to continue providing ad-hoc impact-related support to ELIXIR Nodes, Platforms and Communities	These "clinics" are responsive to the needs of ELIXIR partners and typically take the form of informal meetings where mentoring is provided, along with guidance and suggestions, to solve specific impact challenges

[47] https://elixir-europe.org/about-us/impact

[48] https://elixir-europe.org/focus-groups/impact/documents

[49] https://elixir-europe.org/internal-projects/commissioned-services/impact-evaluation

Recommendation 6: Establish adequate framework conditions for effective governance and sustainable long-term funding for research infrastructures at every stage in their lifecycle, together with effective management

ELIXIR Nodes operate in unique local environments, responding to different funding ecosystems and national priorities. ELIXIR Nodes are also resourced to different levels, have different levels of maturity and have their own processes for including new partners and services within their Node. Despite this diversity, there are many similarities and common requirements shared by Nodes - namely the need to have effective framework conditions in place for effective governance and management. Without good governance and professional operations, national funders will not invest in and sustain ELIXIR Nodes.

The actions ELIXIR can carry out to support successful operations span a complex landscape of three connected levels: institutional, national and European. ELIXIR Nodes must be proactive in understanding the institutional rules, as well as the national and European landscapes. ELIXIR aims to actively support multilayered governance and efforts of its Nodes and their national positioning to maximise the funding landscape on each available level to best support ELIXIR's requirements and emerging needs. In addition ELIXIR also responds to EU-level funding opportunities, and aims to position Nodes for success in these efforts. EU funding, in particular through the Horizon Europe programme as well as the Digital Europe and EU4Health programmes present opportunities to ELIXIR Nodes to run services for local and international user communities.

Actions of relevance to Recommendation 6: 'Establish adequate framework conditions for effective governance and sustainable long-term funding for research infrastructures'.

Action	**Notes**
Institutional	
Support ELIXIR Nodes in their national operations, including establishing suitable governance, project delivery and monitoring, and scientific oversight mechanisms	A number of ELIXIR Nodes have established national-level operational structures that mirror Europe-level structures
Increase the focus on Node development and capacity building in the ELIXIR Programme 2024-2028	Subject to approval from ELIXIR Board, the 2024-2028 Scientific Programme will scale up activities around Node development and capacity building (Tier 3)
Continue to encourage appropriate referencing of ELIXIR resources in relevant funding calls and data management policies (especially guidance for grantees)	ELIXIR and its individual resources are frequently referenced in text for EU-funding Calls and EU Open Science policies. These will continue to be tracked, and new, concerted efforts made to

	track references to ELIXIR in national data management policies
National level	
Support the development of sustainable business model for new services such as the provision of data management support	Work being developed by WP1 of CONVERGE[50]. A number of Nodes (e.g. Sweden, Switzerland, Norway and Netherlands) already provide such a service. Organise workshops on the topic of sustainability of services to identify challenges and discuss possible solutions
Support grant applications by ELIXIR Nodes through the provision of Letters of Support by the ELIXIR Hub	The Hub regularly provides such Letters of Support in the context of e.g. national roadmap funding applications
Expand the Membership of ELIXIR to additional countries	Work with national bioinformatics communities and Ministries of Science in potential Member States to support their path towards Membership (or Observorship) in ELIXIR. Doing so will increase the ELIXIR budget and lead to the additional investment of national funding for national bioinformatics communities
European level	
Work to increase the importance of the sustainability of software and other project outputs beyond data with national and EU funders	Implement communications and advocacy efforts targeted at funders, showing the value of software and other digital assets
Positioning ELIXIR in relation to Horizon Europe and EU priorities	Implement advocacy work to funders ensuring tha ELIXIR, its needs and benefits are considered when topic text is developed. This will take place in relation to Horizon Europe and associated Missions and Partnerships and ensure that funders of research projects that generate data and digital assets are aware of the expertise and services provided by ELIXIR Nodes
Partner in and coordinate in EU proposals in scope of ELIXIR	Ensure that opportunities from EU funding programmes are communicated to Nodes, with Hub or Node-led proposals to various funding programmes optimised through
Work to demonstrate the benefit to national funders of engagement in EU-level programmes and initiatives	Given current uncertainty around future participation of Switzerland and UK in Horizon Europe, in discussions with funders ELIXIR will advocate for a speedy and successful association

[50] https://docs.google.com/document/d/1iLrRTAaHK5UP0kWPOGxDWHoxpmUiHLY-oOUSkqWTkDU/edit

Recommendation 7: Foster broader coordination at National and European levels, when designing processes for planning and supporting national and pan European RIs and so enhance their strategic value

ELIXIR Nodes operate in national ecosystems, interacting with other research initiatives and research infrastructures. The activities carried out by Nodes, and the services they provide, must therefore respond to national priorities and interact with the strategic investments in science and infrastructure being made in those regions. Examples include national open science policies of funders, which will often encourage users to use ELIXIR's open science services. Likewise the respective Smart Specialisation Strategy[51] of that region may provide a domain or technology focussed priority with which the Node has expertise, such as fisheries and aquaculture, or industrial biotechnology.

In terms of major national investments that interlink with ELIXIR, these include the national implementation of the European Open Science Cloud and investments in high-performance computing. Increasingly EU countries that are committed to EU-wide data-generation initiatives such as the 1 Million Genomes Initiative see the national ELIXIR Node as the national implementation partner to deploy the required infrastructure for cross border data analysis.
Information exchange between experts in ELIXIR Nodes and between those experts and external stakeholders remains crucial. ELIXIR has many operational groups and structures and the primary purpose of most of these is to enable information exchange between those involved. Platforms, Communities and Focus Groups enable experts to share information and discuss latest developments, ensuring that knowledge is spread across national boundaries bringing value to existing Member States.

Equally, at the national and European-level, communication with stakeholders is important - these include users in academia and industry, policy-makers and funders, partners in ELIXIR Nodes and also collaborators from other ESFRIs and international partners. Dedicated outreach mechanisms are required to engage and communicate with these stakeholders.

Actions of relevance to Recommendation 7: 'Foster broader coordination at National and European levels'.

Action	Notes
Enable discussion and information exchange via Node Coordinator's group, support the long-term development of Nodes	Utilise technical and operational knowledge from ELIXIR Nodes so information is exchanged and shared between countries.

[51] https://s3platform.jrc.ec.europa.eu/

Support European-level coordination carried out by experts in Platforms, Communities and Focus Groups[52]	Whilst ELIXIR brings together national communities via national Nodes, domain or technology focussed experts are connected by other means, enabling information exchange. Continue to monitor the portfolio of Communities and Focus Groups to ensure new developments are responded to sufficiently.
Communicating to stakeholders	ELIXIR's Communication Strategy[53] provides the framework and context for communications and outreach to stakeholders
Cultivate relations with international, strategically-important organisations, initiatives and projects, and promote ELIXIR's services to the world	Implementation of ELIXIR's International Strategy[54]

Contact

Andrew Smith, Head of ELIXIR External Relations, andrew.smith@elixir-europe.org

Corinne Martin, Programme Manager - Impact and International, corinne.martin@elixir-europe.org

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[52] https://elixir-europe.org/how-we-work
[53] ELIXIR's Communication Strategy: https://drive.google.com/file/d/1IJvxe9WGZ4VOWjvNntsrgH4gfJZT5qve/view
[54] ELIXIR's International Strategy: https://f1000research.com/documents/8-1583