ELIXIR
Scientific Programme
2024-28
Foreword by ELIXIR Director

During its first ten years, ELIXIR has grown into a mature organisation and a vibrant community. ELIXIR works with life scientists in all fields, from molecular structure and genomics to biodiversity and agricultural research. Over the ten years the core mission of ELIXIR has remained unchanged: to connect data and people across national borders and scientific disciplines by coordinating infrastructure and bringing together groups of experts.

ELIXIR is rooted in bioinformatics, the science of transforming large-scale datasets into insights in the molecular and cellular sciences. Curiosity-driven and investigator-led projects provide the foundation of data-driven research into the societal challenges of food security, health and the environment. Life-science data forms the bedrock of a strong bioeconomy.

Ten years ago, in the first Scientific Programme, we described how ELIXIR would help researchers to access and analyse life science data. Our 2024-28 Programme sets out the ambitions for ELIXIR’s second decade. I hope you are as excited as I am.

Niklas Blomberg, ELIXIR Director
Cambridge, UK, 2023
ELIXIR is a distributed infrastructure organised around national data infrastructures called Nodes. Nodes are composed of national centres of excellence in bioinformatics, including both universities and research institutes. Each Node brings together services, standards and resources, and has a lead institute acting as coordinator. Collectively, Nodes bring together experts in all fields of life science data. ELIXIR’s strength is this collaborative network of experts, working together to enable life science researchers throughout the world to access and analyse life science data.

Values
WE WORK TO BENEFIT EVERYONE
WE ARE TRUSTED
WE WORK WITH A SPIRIT OF OPENNESS
WE STRIVE FOR EXCELLENCE
WE WORK IN AN ENVIRONMENT OF RESPECT

Identity
WE ENABLE SCIENTISTS TO ACCESS AND ANALYSE LIFE SCIENCE DATA

Purpose
TOGETHER WE ACCELERATE THE UNDERSTANDING OF LIFE

www.elixir-europe.org
To understand life we need to study biology at all scales, from the molecular details of proteins to the global complexity of complex ecosystems. Rapidly developing techniques such as artificial intelligence, combined with the integration of molecular, physiological and imaging data, will profoundly impact the biomedical and life sciences. ELIXIR’s role is to support researchers so data can be effectively discovered, managed and used in collaborative European research projects.

Putting data to good use is challenging. Life science data are large, complex and distributed. For scientists to make use of such data, both in analysis and advanced modelling, they must work to make this wealth of biological data resources. We must work to make this wealth of information and knowledge visible, interoperable and reusable, particularly by the applied sciences.

Enabling and responding to advances in cellular and molecular research will drive the life sciences

Cellular and molecular biology are developing at pace, with advances driven by novel technologies providing new insights and diverse types of data. In turn, data generates new techniques; genomics, proteomics and metabolomics would not be possible without carefully curated biological data resources. We must work to make this wealth of information and knowledge visible, interoperable and reusable, particularly by the applied sciences.

The application of molecular technologies is critical to understanding the diversity and breadth of life on Earth and to help drive effective mitigations to biodiversity loss. Supplying enough food to feed a growing population requires improved crops and changes to agricultural and farming practices. New pathogens affect people, livestock and crops. The insights of molecular sciences living in a common language, along with common solutions, to these areas.

Enabling and responding to advances in cellular and molecular research will drive the life sciences

Biodiversity, food security and pathogens are interrelated societal challenges

Increased understanding of disease is fundamental to developing diagnostics, preventive measures and treatments. The understanding of difficult datasets must be sizable and extensive to capture mod- est effects and avoid loss. Large European partnerships, such as the European Genomics Data Infrastructure, are therefore necessary. Genomics raises ethical questions, the risk of discrimination and potential threats to privacy. ELIXIR must be part of this conversation and develop services and practices trusted by all stakeholders.

The promise of genomics research to improve health and disease outcomes

To analyse data, researchers need access to diverse, high-quality, interconnected and meaningful data at scale. To deliver on this promise, data, workflows, models, analysis and compute resources all need to be interoperable and available across borders.

ELIXIR’s ambition is to help Europe to have a robust, connected network of established services, internationally recognised data resources and enabling technologies that meet the data needs of life science researchers. Open and reproducible science is critical to maximising the values of publicly-funded research and must be supported by accessible infrastructure.

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Connecting tools, data, experts and countries

ELIXIR will develop its infrastructure as a distributed, pan-European network of services that are stable, consolidated, avoid redundancy and duplication, and form a coherent Europe-wide research ecosystem. As well as cross-European collaboration, each jurisdiction must continue to provide local resources, for example to comply with data sovereignty. To enable this, we will build a decentralised architecture to accommodate dependable international services with interoperable interfaces and common standards.

We will know when we have achieved our ambition when:

- Europe’s leading researchers rely on ELIXIR’s guidance and services to manage, analyse and publish fish data from ground-breaking cellular and molecular research.
- Large research datasets connecting biodiversity, agriculture and emerging pathogens are assembled, integrated and analysed in the context of environmental and socioeconomic factors.
- ELIXIR will be part of this conversation and develop services and practices trusted by all stakeholders.
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ELIXIR’s purpose is to accelerate the understanding of life by facilitating data-intensive research. Scientists should be able to collaborate easily across borders to build large, multidisciplinary datasets for advanced analysis and modelling. The 2024-28 Programme will:

- **Science**: Enable scientists to access and analyse life science data.
- **Technology**: Deliver services to support federated data management and analytics in life science.
- **Nodes**: Equip national Nodes for successful long-term operations.
- **People**: Develop people and capacity to benefit science and society.

ELIXIR's 2024-28 Scientific Programme is constructed from four interconnected tiers, each mapping directly to a strategic goal of the 2024-28 Programme.

Together, ELIXIR Nodes operate the services that allow data to be discovered, accessed, and analyzed. The Nodes provide data management expertise and services, and support scientists with the licensing of data into international deposition databases. ELIXIR Nodes are funded by national funders, often through national research infrastructure roadmaps. A distributed infrastructure builds on national operations, we will therefore invest in our Nodes and the services they run.

The foundation for ELIXIR’s operations is people. To successfully build a federated ecosystem that supports scientists across the whole of Europe, each of our Nodes needs highly qualified personnel to operate national elements in the federation, for research data management and other advanced user support. This requires specialised skills and knowledge, so we therefore run a comprehensive training and capacity building programme which will be further expanded in the next Programme.

**Science**
- **Enable scientists to access and analyse life science data.**

**Technology**
- **Deliver services to support federated data management and analytics in life science.**

**Nodes**
- **Equip national Nodes for successful long-term operations.**

**People**
- **Develop people and capacity to benefit science and society.**
Science

As Europe’s distributed research infrastructure for life science data, our purpose is to advance research by enabling scientists to access and analyse life science data of unprecedented scale and complexity across countries.

The world faces critical societal challenges over the coming decades where the remarkable biodiversity of planet Earth must be sustained at the same time as providing food for eight billion people. We must also be prepared for the inevitable emergence of new pathogens and enable data-driven decision-making to become the norm in policy and healthcare.

ELIXIR serves the whole life science community. Our role is to address the three scientific themes in combination, adopting a coordinated approach across our existing portfolio of communities and projects to allow scientists to integrate life science, social science and environmental data.

ELIXIR acts as the trusted coordinator for sensitive data management and analysis in the life sciences. For the infrastructure to operate in a federated landscape it is essential to organise data science and analysis across our existing portfolio of life science, social science and environmental data.

Case Study

Enhancing biodiversity knowledge with molecular sequence data

Molecular sequencing data is now routinely used to enhance biodiversity data in GBIF, the data infrastructure aggregating global biodiversity data.

The enhancement is achieved by geo-referencing the location of samples in the sequence record in EMBL, an ELIXIR Deposition Database, which is regularly uploaded to GBIF.

This furthers our understanding of individual species in GBIF and helps locate the missing ‘dark taxa’, which are difficult to survey using traditional methods.

Waterhouse, F1000Research 2022 https://doi.org/10.12688/f1000research.1544/4

Cellular & molecular research

Cellular and molecular biology are core to ELIXIR. Fundamental, curiosity-driven science is critical to finding solutions to the major challenges facing humanity today. The provision of a data-centric infrastructure for the rapidly developing molecular and cellular sciences is a key part of the 2024-28 Programme, covering both basic and applied research.

We will enhance our data services and software provision for nucleic acids, proteins and other biomolecules to accommodate the latest developments in experimental and analysis techniques. Cellular and molecular biology will create new demands for multi-omics and multi-modal analysis, including imaging. We will develop methods and partnerships to meet these needs. Modelling at all scales will become an increasing challenge and we will extend our expertise in reusable data and software to include FAB models.

Biodiversity, food security & pathogens

Maintaining biodiversity, ensuring food security, and combating pathogens are critical societal challenges that Europe will face over the next decade. The application of molecular sciences and other data-intense disciplines offers powerful solutions to address all three challenges. The importance of these sciences in contributing to societal challenges is also widely recognised by major international and national funding bodies and is reflected in their research priorities.

In the 2024-28 Programme we propose to apply the operational model successfully used in coordinating human genomic data to biodiversity, food security and pathogens. There are a number of possible mechanisms to explore, including strategic investments in the Nodes to develop all-scales workflows to meet data management requirements. ELIXIR, operating through its member countries, will continue to develop the human data management landscape.

Human data & translational research

Our vision to facilitate the discoverability, access, reception, storage and analysis of genomics data linked to other data types at an unprecedented scale is being implemented: in the 2024-28 Programme ELIXIR will lead the development of the European Genomic Data Infrastructure and drive the use to translate genomics research into medical applications.

ELIXIR acts as the trusted coordinator for sensitive data management and analysis in the life sciences. For the infrastructure to operate in a federated landscape it is essential to organise data science and analysis across our existing portfolio of life science, social science and environmental data.
Our ambition is for Europe to have a robust, connected network of established services, internationally recognised resources, and federation-enabling technologies for data-centric life science research.

### Technology

ELIXIR will develop its infrastructure as a distributed, pan-European network of services that are stable, avoid duplication, and form a coherent federation.

We will do this by building on our strengths and by continuing to evolve to meet the needs of our users. We have defined three strategic areas:

- Research data management and knowledge sharing
- Reproducible analytics and infrastructure
- Federated service delivery

By anchoring the technology tier of our Programme in data management and reproducible analytics, we create a connected infrastructure to support the FAIR management of all digital objects, including data, software and workflows. By further developing federated service delivery, we enable the complementary skills and expertise of our Nodes to be brought together into a single infrastructure. Furthermore, federation, especially of sensitive data, allows all European life scientists to benefit from the ELIXIR infrastructure, regardless of national borders.

#### Actionable research data management

Connecting data is the key to progress in the life sciences. However, connecting datasets across experimental techniques, organisms and geographies needs careful data curation, metadata annotation and cataloguing. ELIXIR has developed a range of tools which put the ability to create and share high-quality FAIR data into the hands of individual researchers. The RDM4e and the FAIR Cookbook form the nexus of a growing framework of tools for knowledge sharing and research data management tailored to individual research communities. Together with the Data Stewardship Wizard, a tool for data management planning, and FAIRsharing.org, the registry for datasets and standards, ELIXIR has created a complete research data management ecosystem for life science data stewards and researchers.

https://ELIXIR-europe.org/what-we-offer/guidelines

#### Federated service delivery

ELIXIR will develop its infrastructure as a distributed, pan-European network of established services, internationally recognised resources and enabling technologies for data-centric life science research.

ELIXIR has developed as an infrastructure based on the complementary strengths of its Node services. Our ambitions for European researchers to have straightforward access to a robust, connected network of established services, internationally recognised resources and enabling technologies for data-centric life science research.

In the 2024-2028 Programme we will promote closer connections between the Core Data Resources and the contributing life science research. ELIXIR users will need support in understanding, finding, using and contributing to this underlying infrastructure.

In the 2024-2028 Programme we will develop a full software lifecycle foundation, from the development of software management plans to the registration and archiving of software and algorithms. We will extend and standardize the technologies and standards for the description and deployment of complex multi-platform workflows and we will give users access to the resources they need from the growing portfolio of cloud and high performance computing services available to research.

#### Reproducible analytics & infrastructure

Data analysis in the life sciences is characterised by complex, multi-step workflows using a range of different representations, data management technologies, software architectures and compute environments. ELIXIR’s users need support in understanding, finding, using and contributing to this underlying infrastructure.

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#### Provide data and knowledge management infrastructure to support open, data-driven research in the life sciences

ELIXIR provides researchers with infrastructure to enable the creation, analysis, management and re-use of biological data.

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#### Develop our infrastructure to enable end-to-end management of life science software, workflows and containers

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#### Develop a federated pan-European technical infrastructure for life scientists to access data, storage and compute services

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### Case Study

**Active learning research data management**

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**Nodes**

ELIXIR is a distributed research infrastructure bringing together 24 Nodes, which in turn connect over 240 leading institutes and universities in bioinformatics service provision.

ELIXIR Nodes must be well-coordinated, professionally run organisations that meet the needs of national stakeholders by providing high quality support, expertise and services (described in Tier 2) that are aligned with national research priorities.

To be successful over the long-term, these national operations require skilled personnel (described in Tier 4) as well as dedicated funding for service provision and coordination.

In addition, the user base of the de.NBI Cloud was expanded by over 2000 and more than 700 projects were supported.

![Image](https://www.denbi.de/elixir-de)

**Case Study**

**ELIXIR Germany**

Germany became a member of ELIXIR in August 2016 and has grown to encompass 24 contractual partners (universities and research institutions) as well as EMBL Heidelberg.

In 2016, ELIXIR Germany offered 120 services to the life science community, organised the first BioHackathon Germany, the third Industry Forum meeting and played a significant leadership role in ELIXIR Platforms and Communities.

**Node operations**

The organisational capabilities of Nodes need to grow to meet the demands of increasing resource usage and the requirements arising from close collaboration with many national, European and international collaborators. Developments such as the creation of common European data spaces will rely on national implementation, with ELIXIR Nodes increasingly acting as crucial components of bigger infrastructures. ELIXIR Nodes need to grow to meet the demands of increasing resource usage and the requirements arising from complex collaborations with a wide range of stakeholders.

**Alignment of national research priorities & open science policies**

ELIXIR Nodes operate in the context of national open science and research data policies, and they not only manage digital assets produced by research infrastructures but also with other national, European and global projects. However, many national funders do not yet have open science policies or guidelines, and when they do, they don’t always reference ELIXIR resources. We will support Nodes to work with national funders and develop activities that highlight the benefits of ELIXIR-funded open science outputs. We will also work to ensure that national funders recognise ELIXIR Nodes as key components of the data infrastructure when funding major research initiatives.

**Industry & innovation**

ELIXIR’s activities at all levels.

**Impact & long-term sustainability**

ELIXIR’s impact portfolio will continue to mature with a focus on systematic implementation across activities and projects, a level- playing field for all stakeholders, as well as an expansion of efforts to externally communicate ELIXIR’s scientific, socio-economic and societal impacts. We will provide opportunities for Nodes to exchange good practices in securing national funding and explore opportunities to exploit alternative funding sources. Activities to build Node long-term sustainability will be strengthened by the clear demonstration of the impact of ELIXIR’s activities at all levels.

**Nodes have the operational capabilities to contribute to a European infrastructure for data**

**Nodes are aligned with national research priorities and open science policies**

**Nodes are fundamental to national industry ecosystems and engage in EU-wide industry efforts**

**Nodes are empowered and supported in their efforts towards long-term sustainability**
All of ELIXIR’s activities depend on people. ELIXIR’s 2024-2027 Programme highlights the importance of life-long learning, allowing individuals to stay abreast of technical developments, strive for excellence and see training as an intrinsic part of working life.

It is people with specific and highly specialised expertise and skills who design, implement and maintain the ELIXIR infrastructure. Developing employees is critical for ELIXIR Nodes, along with retaining and staff and knowledge.

To maintain and develop ELIXIR’s sustainability and strength, the 2024-2027 Programme will also look outside ELIXIR to provide our service users with the skills and resources they need to gain maximum value from our European-wide data infrastructure.

The foundation of ELIXIR’s operations is people: our users and our Node members. Both require skills that are in short supply, so we will run an ambitious training and capacity building programme. ELIXIR will work with our service users to develop a people network that is diverse, quality, and inclusive to seek and understand how best to promote the participation of under-represented groups.

Case Study

ELITMa

The ELIXIR Training Programme in Management (ELITMa) aims to build capacity for infrastructure management at Node level. The Programme is divided into seven modules, enabling participants to build their own training pathway. The modules include: ELIXIR Governance and Organisational Behaviour; Project Management; Communication; Financial Management; Advocacy, Leadership, and Data Management. Each module addresses specific questions related to research institutions and infrastructure management and is tailored to use cases from ELIXIR activities.

ELIXIR has a strong and successful training community spanning all Nodes. The creation and delivery of targeted training, along with the development and maintenance of ELIXIR’s Training Portal (TTP), supports Europe’s life scientists and bioinformatics experts to use ELIXIR’s tools and services. ELIXIR will continue to strengthen national training programmes, expand bioinformatics training capacity, and enhance access to expertise across Europe, and empower researchers to use ELIXIR’s resource portfolio.

ELIXIR will build capacity and support Node personnel to run efficiently organised Nodes as part of a distributed research infrastructure. The size and complexity of projects such as the European Genome-phenome Data Initiative (EGP) and the Eurofins-supported projects (e.g., Open Science Cloud), will continue to strengthen national research infrastructure as a whole to stay abreast of technical developments, strive for excellence, and embrace ongoing personal development.

Technical experts need to be supported in learning new technologies to meet the growing need for expertise in specific areas such as Life Sciences, Bioinformatics and big data. ELIXIR will continue to provide access to the curriculum and resources to support in learning new technologies to meet the growing need for expertise in specific areas such as Life Sciences, Bioinformatics and big data. ELIXIR will continue to provide access to the curriculum and resources to support in learning.

ELIXIR is a diverse and inclusive network of people who are appropriately credited for their work.

Users of ELIXIR services

ELIXIR services have access to training, resources and expertise

Hodes are well equipped to efficiently manage and run a distributed infrastructure

ELIXIR technical and scientific staff have the skills needed for operational excellence and impact

ELIXIR is a diverse network of people who are appropriately credited for their work.
European partnerships

The world of bioinformatics is highly interconnected, with multiple dependencies between different services and organisations, within countries, across Europe and globally. ELIXIR connects over 240 universities and research institutes, and we collaborate with many other organisations and initiatives to help scientists access and analyse life science data. These include global standard-setting organisations, national bioinformatics initiatives in countries outside ELIXIR, research infrastructures with data-related needs, and industry and technology-focused initiatives.

Working in partnership with these organisations helps ELIXIR better understand user requirements, minimises duplication of effort and improves service interoperability across the globe.

The European High Performance Computing Joint Undertaking (EuroHPC JU) is an initiative for advanced high performance computing. Several ELIXIR Nodes are tightly connected to the consortia that are deploying pre-exascale computing capacity for research use. These new computing capacities will be deployed in Finland, Italy and Spain, with the ELIXIR Nodes in each country coordinating the national efforts. As a research infrastructure, ELIXIR plays a key role in bringing researcher requirements to the EuroHPC consortium.

The ambition of the European Open Science Cloud (EOSC) is to develop a ‘web of FAIR data and services’ for science in Europe. ELIXIR has long identified EOSC as a significant strategic partner, participating in EOSC projects on many aspects of the underlying technologies and applications enabled by this shared vision.

ESFRI

ELIXIR has forged close collaborations with other research infrastructures on the European Strategy Forum on Research Infrastructures (ESFRI) roadmap. This includes BBMRI-ERIC, Euro-BioImaging and EMPHASIS, which has led to joint meetings, workshops and formal collaboration strategies.

Several ESFRIs provide access to technologies that generate data for which ELIXIR has solutions, and many also provide complimentary services that, along with ELIXIR’s activities, help to improve the life science data ecosystem for users.

In the 2024-2028 Programme, ELIXIR will seek to formalise collaboration strategies with a small number of critical ESFRIs where there is deemed to be strategic benefit. These include ESFRIs covering health, image technologies, biodiversity and industrial biotechnology.

Global collaborations

Case Studies

ESFRI

The European High Performance Computing Joint Undertaking (EuroHPC) is an initiative for advanced high performance computing. Several ELIXIR Nodes are tightly connected to the consortia that are deploying pre-exascale computing capacity for research use. These new computing capacities will be deployed in Finland, Italy and Spain, with the ELIXIR Nodes in each country coordinating the national efforts. As a research infrastructure, ELIXIR plays a key role in bringing researcher requirements to the EuroHPC consortium.

The European Open Science Cloud (EOSC) is an initiative for advanced high performance computing. Several ELIXIR Nodes are tightly connected to the consortia that are deploying pre-exascale computing capacity for research use. These new computing capacities will be deployed in Finland, Italy and Spain, with the ELIXIR Nodes in each country coordinating the national efforts. As a research infrastructure, ELIXIR plays a key role in bringing researcher requirements to the EuroHPC consortium.

Global Alliance for Electrification and Health

The ambition of the European Open Science Cloud (EOSC) is to develop a ‘web of FAIR data and services’ for science in Europe. ELIXIR has long identified EOSC as a significant strategic partner, participating in EOSC projects on many aspects of the underlying technologies and applications enabled by this shared vision.

ESFRIs

For a number of years, ELIXIR has built strong links with the Office of Data Science Strategy at the National Institutes of Health (USA). This relationship will continue through joint events at international conferences, representation at meetings and technical workshops, and the facilitation and sponsorship of study visits or secondments. In the new Programme, ELIXIR will foster other collaborations with national-level bioinformatics communities beyond Europe where there is mutual benefit and alignment in goals.

Building on strong links with the Australian BioCommons

The on-going collaboration between ELIXIR and the Australian BioCommons has led to considerable mutual benefits in a range of technical areas such as tools, compute and training. The collaboration strategy was formally renewed in 2023 and will expand in scope to further capitalise on the synergies of our two organisations.

Case Studies

The ELIXIR-GA4GH Strategic Partnership

The ELIXIR-GA4GH Strategic Partnership, was founded on a collaboration agreement from 2017, and formalised as a partnership in 2019. Building on these foundations, we hope to develop an even stronger collaboration in the 2024-28 Programme. We will coordinate the creation and implementation of the GA4GH suite of interoperable standards and policy frameworks to tackle technical and regulatory hurdles to genomic data access in Europe and globally.

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### Financial tables

#### Table 1: Projected ELIXIR Financial Plan 2024-2028

<table>
<thead>
<tr>
<th>Year</th>
<th>Income</th>
<th>Expenditure</th>
<th>Surplus/(Deficit)</th>
<th>GENERAL RESERVE</th>
</tr>
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<tbody>
<tr>
<td>2024</td>
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<td>€12,112,000</td>
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<tr>
<td>2025</td>
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<tr>
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<td>-€791,000</td>
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<td>2028</td>
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<td>€12,329,000</td>
<td>-€1,323,000</td>
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**Total Internal Expenditure before Support and Admin Infrastructure Costs**: €8,162,000 €4,478,000 €9,846,000 €8,194,000 €8,916,000

**Support and Admin Infrastructure Costs**: €962,000 €844,000 €887,000 €906,000 €882,000

**Grants Expenditure**: €2,988,000 €2,524,000 €2,219,000 €2,419,000 €2,531,000

**Total Expenditure**: €12,112,000 €7,846,000 €12,952,000 €11,519,000 €12,329,000

**Surplus/(Deficit)**: -€1,294,000 €2,664,000 -€2,587,000 -€791,000 -€1,323,000

#### Table 2: Member State contributions 2024-2028

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
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<td>Slovenia</td>
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<td>€22,550</td>
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Note: NB is based on the most recent three-year period for which complete NB data is available (period 2019-2021). The 2023 contribution is based on the 2023-24 Programme developed in Brussels.

*UK pays contribution in Sterling.