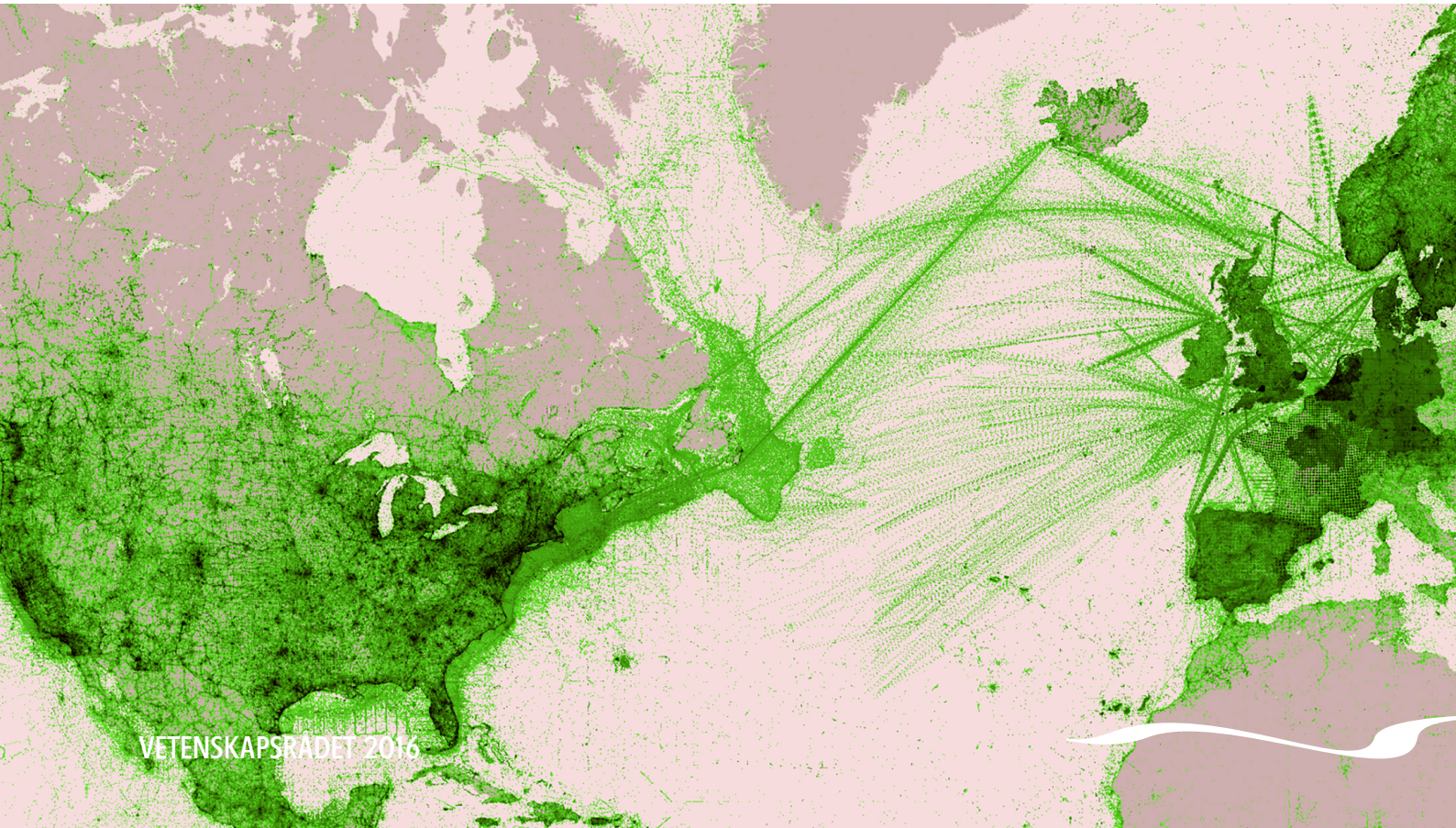
Vetenskapsrådet

APPENDIX TO THE SWEDISH RESEARCH COUNCIL'S GUIDE TO INFRASTRUCTURES



VETENSKAPSRÅDET 2016

APPENDIX TO THE SWEDISH RESEARCH COUNCIL'S
GUIDE TO INFRASTRUCTURES

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PREFACE

Researchers' access to high-class tools – research infrastructure – is central to the development of research and innovation. Examples of this include central or distributed research facilities, databases, biobanks or large-scale computation resources.

The purpose of the Swedish Research Council's support for research infrastructure is to provide long-term conditions in which to conduct research of the highest international quality, ensure domestic access to research infrastructure, facilitate renewal within the Swedish infrastructure landscape and underpin the far sightedness of financing and participation by higher education institutions.

The Research Council has been working since 2015 to implement a new model for prioritising and financing infrastructure. In 2015–2016 and within the scope of this new model, the authority conducted an inventory of the new infrastructure needs identified by research groupings or the senior management of the country's higher education institutions. It is those areas that have been assessed in this process to be of the highest priority that are included in this appendix.

As the largest proportion of the Research Council's budget for research infrastructure is locked into long-term commitment, it has become increasingly important to choose priorities from among existing and new undertakings in order to ensure that resources are used in the best way. The Research Council's role is to provide the prerequisites for research at the very forefront by contributing to ensuring that Swedish infrastructure is at the forefront.

The Council for Research Infrastructures (RFI) would like to thank several people and groups who have contributed to the work on this appendix. In addition to all those who have submitted proposals concerning new infrastructure needs in conjunction with the inventory and the RFI's evaluation panels, which evaluated the proposals received and developed texts, consultation with the Research Council's scientific councils and the universities' reference group for research infrastructure has been very valuable.

Björn Halleröd
Secretary General of Research Infrastructures

Jan-Eric Sundgren
Chair of the Council for Research Infrastructures

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SUMMARY

Around 150 proposals from higher education institutions, public authorities with research responsibilities, funding bodies and research groupings were received by the Swedish Research Council during the inventory of needs for new or upgraded/improved research infrastructure conducted in 2015–2016. The inventory was the first stage of the implementation of the Research Council's new model for the prioritisation and financing of infrastructure that was adopted by the council's board in 2014.

The evaluation panels under the Council for Research Infrastructure (RFI) have assessed all proposals received on the basis of criteria such as scientific relevance, national interest and strategic considerations. The evaluation panels' assessments also took into account statements from the Research Council's scientific councils and committees and the universities' reference group for infrastructure, which consists of deputy vice-chancellors from the ten largest universities and a representative from the Association of Swedish Higher Education.

This assessment resulted in a proposal for categorisation that was then adopted by the RFI. The thematic areas that were placed into the categories A1 (high scientific and strategic value, mature enough for implementation beginning in 2018) and A2 (high scientific and strategic value, but not mature enough for implementation) in the assessment are described in more detail in this appendix to the Swedish Research Council's Guide to Infrastructures. This concerns 11 areas within the categories A1 and 13 within category A2. In addition to this, infrastructure for which the grant period ends in 2017 or 2018 and is thus eligible to apply for infrastructure grants in the call for proposals in 2017 is also listed. In some cases, this means that they need to be part of one of the thematic areas described in A1.

In the appendix, there is also a description of the background to the model for prioritisation and financing of research infrastructure, how the assessment of the proposals of needs has gone about and the future management of the call in 2017 and the forthcoming strategic guide, The Swedish Research Council's Guide to Infrastructures.

SAMMANFATTNING

Vid den inventering av behov av ny eller uppgraderad/utvecklad forskningsinfrastruktur som Vetenskapsrådet genomförde under 2015-2016 inkom omkring 150 förslag från lärosäten, myndigheter med forskningsansvar, finansiärer och forskargrupperingar. Inventeringen var det första steget i att implementera Vetenskapsrådets nya modell för prioritering och finansiering av infrastruktur för forskning som beslutades av rådets styrelse 2014.

Beredningsgrupper under Rådet för forskningens infrastrukturer (RFI) har bedömt alla inkomna förslag efter kriterier som vetenskaplig relevans, nationellt intresse och strategiska överväganden. I sina bedömningar vägde beredningsgrupperna även in yttranden från Vetenskapsrådets ämnesråd och kommittéer och lärosätenas referensgrupp för infrastruktur som består av vicerektorer från de tio största universiteten samt en representant från Sveriges universitets- och högskoleförbund (SUHF).

Bedömningen resulterade i ett förslag på kategorisering som sedan fastställdes av RFI. De tematiska områden som i bedömningen placerades i kategorierna A1 (högt vetenskapligt och strategiskt värde, mogna för implementering fr.o.m. 2018) och A2 (högt vetenskapligt och strategiskt värde, men inte mogna för implementering) beskrivs närmare i denna bilaga till Vetenskapsrådets guide till infrastrukturen. Det rör sig om 11 områden inom kategorin A1 och 13 inom kategorin A2. Utöver dessa beskrivs även infrastrukturer vars bidragsperiod tar slut under 2017 eller 2018 och som därmed är behöriga att ansöka om infrastrukturbidrag i utlysningen 2017. I vissa fall innebär det att de för att söka behöver ingå i ett av de tematiska områdena som beskrivs i A1.

I bilagan beskrivs även bakgrund till modellen för prioritering och finansiering av forskningsinfrastruktur, hur bedömningen av behovsanmälningarna gått till samt den fortsatta hanteringen med utlysning 2017 och kommande strategisk vägvisare för infrastruktur, Vetenskapsrådets guide till infrastrukturen.

1 BACKGROUND

1.1 About the model

A new model for the prioritisation and financing of research infrastructure was adopted by the Swedish Research Council's board in 2014. This model, which is being gradually implemented up to 2019, involves the prioritisation of infrastructure taking place through a recurring cyclical process in which conducting an inventory of infrastructure needs and a scientific and strategic assessment and prioritisation process are central components. In the calls for applications, which from 2015 take place every other year, new infrastructure needs, which are prioritised on the basis of the inventory of needs, i.e. a selection of the infrastructure investments presented in the guide's appendix, will compete with existing infrastructure that applies for continued grants.

The aim of this procedure is to encourage both continuity and renewal, but only when it comes to high-class infrastructure that is used by the best researchers in each area. Infrastructure that is no longer competitive will not be able to obtain funding from the Research Council. Support from the Research Council will normally cover a maximum of half the cost of the infrastructure. The remaining portion is to be covered by other contributory parties, primarily the country's higher education institutions.

The inventory of infrastructure needs is to take place every other year and the subsequent calls for applications will be based on the scientific and strategic priorities that the RFI makes of the proposals received during the inventory.

A strategic guide, The Swedish Research Council's Guide to Infrastructures, is published every four years. The aim is to provide an overview of Sweden's involvement in national and international infrastructure and, above all, to indicate a desired direction for the Swedish efforts in terms of research infrastructure and identify issues that should be dealt with over the course of the coming period.

An appendix to the guide is published every other year and contains descriptions of the areas that are regarded to be of the highest priority to the development of Swedish research. This is based on the results of the inventory of needs.

1.2 Delimitation

The Research Council's responsibility for research infrastructure of national interest includes both national and international infrastructure. However, this responsibility does not include equipment, infrastructure that is local in nature or infrastructure that falls largely within the area of responsibility of another public authority. As these do not fall within the Research Council's area of responsibility, they will also not be included in the council's calls for applications or included in this appendix.

1.3 Assessment of the proposals of needs 2015-2016

The proposals of needs that were received by the Research Council in autumn 2015 have been assessed on the basis of their scientific and strategic value by the RFI's five evaluation panels. This process has also taken into account the opinions of the universities' reference group for infrastructure[1] and the Research Council's scientific councils and committees. The evaluation groups have then made an overall recommendation to the RFI.

In the assessment process, the majority of the proposals of needs received were groups into thematic areas that were then divided up into seven categories from A1 to D[2], with A1 being assessed as the highest priority.

[1] Representatives at the senior management level from the ten largest Swedish higher education institutions and a representative from the Association of Swedish Higher Education.

[2] A1= Relevant to be considered as infrastructure of national interest, mature enough for call for proposals

A2= Relevant to be considered as infrastructure of national interest, not mature enough for call

The thematic areas that belong to the categories A1 and A2 have been included in this appendix. The areas that are considered scientifically and strategically important and where the plans for national infrastructure are sufficiently clear that they are able to begin in 2018 (following a call for proposals in 2017) have been classified as A1, while those that are of high scientific and strategic value, but require more time before they can be considered for implementation have been classified as A2. Classifying an area as A1 is thus a prerequisite, but not a guarantee for being able to apply in the call for applications in 2017.

The earliest that areas that have been deemed A2 can be included in a call for applications is 2019, i.e. after the Research Council has conducted the next inventory of needs. The areas classified in the categories B-D are not included in the guide's appendix.

Decisions concerning the content of this appendix and the focus of the call for applications in 2017 were made by the RFI in September 2016. The text in the appendix has then undergone necessary editing prior to publication.

1.4 Call for applications 2017

A decision about which areas from category A1 that will be included in the call for applications in 2017 was made by the RFI in autumn 2016. However, the call for applications will not be restricted to those that were submitted in a proposal of need. Other actors who want to participate in the construction or operation of infrastructure within the areas that are included in the call and who fulfil the criteria in the call can be included in an application. The appendix to the guide only imposes limitations on the areas considered in applications for grants for research infrastructure, not which organisations can apply for funding.

In addition to the new areas, applications can also be submitted for continued grants for existing infrastructure for which the current grant period is coming to a close. The third section, Research infrastructure currently funded that is eligible for the infrastructure call 2017, contains a list of these.

In addition to the infrastructures listed in the section referred to above, grants can also be applied for to fund increased Swedish involvement in international infrastructure in which Sweden is already participating, see section four. This should correspond to defined processes within the infrastructure in question, such as calls for in-kind contributions or similar, to which Swedish scientists intend to contribute and require additional funding in order to do so.

The call for applications is published at the beginning of 2017; more information will be provided on the Research Council's website, www.vr.se, in autumn 2016.

1.5 The future process

The next inventory of needs will be initiated in 2017 using the same model as in 2015, but with some adjustments. Information about the criteria and schedule that will apply will be announced over the course of the year. The results of the inventory will be presented in 2018.

The strategic guide, The Swedish Research Council's Guide to Infrastructures, is published in 2018 and, with a 5-10-year perspective, it will indicate the desired direction of travel that ensures Swedish researchers to have access to first-class research infrastructure. The guide is produced in parallel with the Research Council's work to produce input material for the 2020 government research bill and will also contain recommendations concerning investments and systemic changes.

B1= Not relevant to be considered as infrastructure of national interest due to lack of scientific relevance

B2= Not relevant to be considered as infrastructure of national interest due to lack of feasibility

B3= Not relevant to be considered as infrastructure of national interest due to lack of national interest

C= Need can be handled by existing national or international infrastructure

D= Should be handled by other authority/funding agency

1.6 Timeline

2014

- The Research Council's board adopt a new procedure for handling infrastructure support 2015
- Call for applications on "Infrastructure of National Interest" with stricter conditions for applications and grants
- Inventory of needs begins ahead of the drawing up of an appendix to The Swedish Research Council's Guide to Infrastructures

2016

- Appendix to The Swedish Research Council's Guide to Infrastructures based on the inventory of needs and consultation with the higher education institutions and scientific councils is published

2017

- Call for applications on "Infrastructure of National Interest"
- Inventory of needs

2018

- The Swedish Research Council's Guide to Infrastructures 2018, including appendix based on the inventory of needs, is published

2019

- Call for applications on "Infrastructure of National Interest"
- Inventory of needs

2 DESCRIPTION OF RESEARCH INFRASTRUCTURE NEEDS PER THEMATIC AREA, A1 AND A2

This section contains descriptions of a number of thematic areas in which there are research infrastructure needs that are considered to be of great national interest. Areas in which the infrastructure needs were considered to be of national interest and developed enough to be implemented in the near future are described under "A1", while those described under "A2" were considered to be of equal potential importance, but require more time in order to either set up a national organisation or gather together the various interests within the area.

The intention is for these descriptions to serve as inspiration and guidance for organisations or research groups that would like to develop national infrastructure and funding agencies that are interested in investing in national infrastructure. The Research Council's aim is to describe the challenges and expected impact for each thematic area, but not a definitive solution. It is up to the partners attempting to organise the infrastructure to describe what specific infrastructure is needed and whether a thematic area is best served by one, two or more infrastructures. Infrastructure other than that described in this appendix, with or without funding from the Research Council or with longer funding periods, can be included in the proposed infrastructure. However, it is of the utmost importance that there is a national perspective and that the infrastructures within or close to the thematic area relate to one another, especially if the application involves creating more than one infrastructure for a certain area.

2.1 Relevant to be considered as infrastructure of national interest, mature enough for the call for proposals 2017 – A1

Coordination of biobanks and associated data

Challenge: New opportunities within healthcare are being created as a result of increased knowledge and new technologies. Patients and society are calling for better, safer and more cost-effective treatments. Thanks to methods now available for the large-scale analysis of molecular samples and data, it is thought that the design of individual treatments (known as precision medicine) will revolutionise healthcare in the near future. Together with new technical achievements, biological material and medical data for research and clinical studies are essential if these demands are to be addressed. A coordinated national infrastructure that can provide these resources is required in order to achieve the goal of improved healthcare that encompasses precision medicine.

Description: A national infrastructure for biobank-research consists of biobanks that are effectively managed, coordinated, standardised and accessible for research. They serve as a platform for effective healthcare services, high quality research and the development of new medical treatments within the life sciences industry.

Competitive biobanking relies on well-functioning infrastructure, strong expertise and connections to supporting infrastructure. This requires that the main biobank owners, i.e. research institutions and healthcare providers (the Swedish Association of Local Authorities and Regions, SALAR), collaborate with a shared understanding of how biobanks are to be organised, managed and made accessible for research purposes. Coordination that incorporates common standards, quality measures, ethical rules, networks and data interoperability must be ensured. A clear process for aligning the Swedish biobanks that contains a timeline and a governance and leadership structure is expected. Supporting structures and workflows should be described. Activities funded within the infrastructure should relate to the coordination and efficient usage of biobanks at the national and international level.

Sweden has been a member of the European infrastructure BBMRI-ERIC since 2013. A Swedish national infrastructure for biobank research will be responsible for providing biobank services as the Swedish node of BBMRI-ERIC. Sweden currently has a leading role in the development of European policies for Ethical and Legal and Societal Issues (ELSI) within the European infrastructure, which generates opportunities and collaborations on an international scale. This work can be taken up and developed further.

Expected impact: The alignment of the Swedish biobanks and the establishment of a Swedish hub in order to support scientists conducting biobank research. This should facilitate access to high-quality data and samples, enhance national and international biobank collaborations and also maintain the confidentiality of sample donors. Sweden should maintain a strong profile internationally and attract excellent scientists in the field. In the long term, this should result in increased knowledge and improved healthcare services and thus be of benefit to society.

In this area, the following infrastructures for which the grant period ends in 2017–2018 are currently funded by the Swedish Research Council:

BBMRI-ERIC

Infrastructure for bioinformatics

Challenge: Large-scale data sets, for example those generated through next generation sequencing, proteomics, expression analyses, etc., are no longer being used only in a few genome projects, but are now also being used to address a variety of biological questions, including those relating to complex human diseases. Bioinformatics, the use of computational methods to analyse large biological data sets, has therefore become a vital field in recent decades. The increasing reliance on large data sets in many diverse fields of research means that the importance of bioinformatics support is huge and increasing at an exponential rate. The number of researchers who do not have computational/bioinformatics skills but use large-scale methods is thus steadily increasing and they are all potential future users of a bioinformatics support facility.

Description: The first human genome was published in 2003 and since then, sequencing capacity has increased dramatically, resulting in the production of several human genomes per day, and this trend continues. A similar development can be seen in other -omics areas, including transcriptomics and proteomics. This is fundamentally transforming medical genetics, as well as biology in general, through the sequencing of metagenomes, microorganisms and other organisms of interest.

The establishment of the National Bioinformatics Infrastructure Sweden (NBIS) at SciLifeLab, combined with excellent sample collections, has put Sweden in a good position to make great contributions in this area. As a result, the research activity and the amount of data being produced in this field are increasing dramatically. ELIXIR is the European infrastructure for bioinformatics and Sweden contributes to ELIXIR through the project Human Protein Atlas, which aims to map the human proteome.

The need for bioinformatics infrastructure that is designed to provide both research and development and user support is expected to increase. However, it is important to broaden the present structures so as to provide support for different types of data sets and projects as the field continues to evolve.

Expected impact: The continuous development of bioinformatics infrastructure will benefit many fields of research. The availability of large-scale data, for example through other infrastructures, has already begun to greatly increase our understanding of human biology, microbiome interactions, infection and other fields such as environmental science. A coordinated effort to provide bioinformatics support in order to assist in the analysis and interpretation of data will be central to these efforts.

In this area, the following infrastructures for which the grant period ends in 2017–2018 are currently funded by the Swedish Research Council:

NBIS
ELIXIR

Infrastructure for research based on individual level databases in medicine and the social sciences

Challenge: In Sweden, there are a large number of individual level databases in medicine and the social sciences that are currently operating and generating world-leading research. By international standards, the quality of these databases is very high and of critical importance to scientific impact. However, there are

various challenges associated with the high number and large variety of these databases. One problem is unwanted overlap, while another problem relates to a lack of synergies between different databases. At a time when there is a need to respond to new research questions, stronger collaboration could be a viable strategy and lead to synergies in terms of the collection of new data and the construction of databases.

Description: A large number of databases in medicine and the social sciences have the potential to serve as the basis of important scientific breakthroughs across a wide range of areas. These include areas that address the great contemporary societal challenges. For example, surveys of developments and variations in health status, together with data on other human conditions, are necessary in order to respond to new research questions. Longitudinal surveys are often of great strategic importance in this respect. The value of survey data, longitudinal and otherwise, is often substantially augmented by adding data from various pre-existing population-based registers. Sweden has a very strong comparative advantage in this regard. Such combined databases, generated by linking surveys with register-based data, are valuable in both the national and the international context.

Expected impact: By increasing collaboration between databases in this area, a number of positive outcomes are expected. Together, they will improve the chances of making research breakthroughs. The scope and quality of future surveys will be improved by collaboration with respect to data collection. Data will be more easily accessible. It will be possible to apply new methods for the simultaneous analysis of different databases. Databases in the social sciences and medicine will cover areas that are critical to research over the coming decade and the continued integration of register data will provide the basis for world-class research. This collaboration will also address some of the challenges identified in terms of the databases in medicine and the social sciences; it will be possible to avoid doubling up on the collection of data and may make it possible to devote resources to ensuring adequate response rates (among other things). Furthermore, it will create momentum towards achieving various kinds of synergies.

In this area, the following infrastructures for which the grant period ends in 2017–2018 are currently funded by the Swedish Research Council:

ETF/UGU
ESS-S and ESS-ERIC
ISSP
SHARE-S and SHARE-ERIC
SLOSH
SMC
SNAC-K

Infrastructure for fusion reactor research and development

Challenges: The aim of fusion research is to develop an environmentally friendly and commercially viable energy resource, the fuel for which is practically unlimited. The main obstacles are the extreme conditions under which fusion reactions occur; at temperatures ten times higher than those at the centre of the sun. The main challenges involved in creating a fusion reactor are how to heat, control and diagnose the fusion plasma and how to limit the interactions between the hot plasma and the solid wall.

Description: Fusion research today is focused on the preparations for the upcoming reactor ITER and the proposed demonstration plant DEMO. In Europe, this research takes place in the largest existing fusion device, JET, which is in the UK. It also takes place in medium or small-sized national and international experiments, as well as through theoretical research and modelling.

Recent milestones in fusion research include the experimental confirmation from JET that high performance fusion plasmas can be achieved with the newly installed ITER-like (tungsten/beryllium) wall. The Swedish fusion research community is organised into a ‘research unit’ that is a member of the Euratom funded consortium EUROfusion. EUROfusion provides access to the main European facilities and distributes research and development assignments to its members on a competitive basis. The development of infrastructure for ITER is contracted out by the legal entity Fusion for Energy (F4E). Infrastructure is a key component of the

Swedish fusion program and drives high quality research in areas including plasma diagnostics, analysis of plasma-facing components, plasma control and integrated modelling.

Expected outcome: Fusion infrastructure facilitates Sweden's continued participation in the EUROfusion consortium, providing access to world-leading facilities. This will strengthen Swedish participation in the development of new infrastructure, including instrumentation, analysis facilities and integrated modelling, thus providing a long-term strategic knowledge base for the utilisation of ITER and DEMO.

Infrastructure for the integration and accessibility of data for climate-related research

Challenge: Many important scientific questions related to climate processes and climate change remain unanswered, including those concerning the carbon and water cycles in both the long and the short-term. The successful implementation and evaluation of climate change mitigation actions requires the support of strong empirical data. Many issues are global, which means that Swedish data and that from other countries must be integrated into a coherent whole and be available to Swedish researchers.

Description: A well-coordinated infrastructure for climate-related information (data from environmental measurements and results from reference models) that incorporates data management and expert support will greatly benefit Swedish researchers. Data must be integrated in accordance with international data management standards. Guidelines for data sharing will soon be defined at the national level and are to be accommodated in the database. The full and open sharing of data is a core requirement if we are to tackle today's major complex and multidisciplinary research questions and overarching environmental challenges.

Expected outcome: Further national coordination will allow climate research data to be integrated and will facilitate access to this data. Quality-assured, effective, persistently reliable access to data from both public authorities and researchers will enable Swedish researchers to maintain their leading role in climate-related research, especially that related to Swedish climatic conditions. Actions, technical design and organisation should be coordinated with existing and planned Swedish and international infrastructure. The broad database function envisaged requires the research community to be coordinated and fully engaged in facilitating data access during the development of the system.

Infrastructure for the integration and accessibility of biodiversity informatics data

Challenge: Preserving biodiversity is of fundamental importance if society is to continue benefiting from ecosystem services such as good quality water and air, soil nutrient dynamics, carbon storage and crop pollination. Sweden has a long and distinguished history of conducting biological, ecological and ecosystem research, particularly in areas related to forests, soil ecology, surface water and agricultural systems in the boreal region. The primary focus of much contemporary biodiversity and ecosystems research is currently shifting from single sites and simple model systems to patterns and processes at the landscape level that affect entire biomes and to the generation of knowledge that has system-wide predictive power. This transition is currently progressing rapidly due to both increasing societal needs and advancements in big data science that are being fuelled by advances in information and communications technology.

Description: Accessible and integrated biodiversity informatics data is needed if researchers are to be able to model and analyse processes at the local, regional and global scales and predict the systemic effects of environmental change. This infrastructure will be able to provide researchers with relevant data that is free and easily accessible. There is a need for national coordination so that the data for biodiversity and ecosystems research is integrated and made accessible to both domestic and international researchers. The aim of improving the accessibility of data from both national authorities and researchers is to bring Swedish biodiversity research to the forefront of this field. This need could be met by a comprehensive infrastructure in which existing and new infrastructures are connected to a single common platform. The parts included in this infrastructure should relate to each other and other relevant Swedish and international infrastructures.

Expected outcomes: The infrastructure leads to increased and broadened knowledge of biodiversity that allows Swedish researchers to make use of the full breadth of existing domestic data. The visibility and accessibility of

the data available domestically will increase and should strengthen the research potential of existing data collections. This will demand a high degree of coordination at the national level, and should be carried out in harmony with the new national guidelines for data sharing that are soon to be decided on. The infrastructure is also expected to be a Swedish partner of successful international initiatives for the coordination of biodiversity informatics, with the Swedish infrastructure complimenting and supporting these in an optimal way.

Infrastructure for research based on language data

Challenge: Improved technology and research methods have made it possible to analyse language data (in written, spoken or bimodal form) in new ways. While the existing infrastructures already encompass huge text materials from various sources, there is great potential for research, not only by expanding the text data, but also by integrating other kinds of language material. The challenge lies in promoting the organisation of a national infrastructure that is able to coordinate and link data that has been collected and is stored in various kinds of databases and also in creating a platform for the collection of new data.

Description: Sweden has a long tradition of building language databases for research. Language also figures prominently in a number of Swedish national research infrastructures, as well as in their European equivalents. Other databases that include various kinds of language material could be integrated and generate opportunities for ground-breaking research in a number of areas, ranging from historical studies to the importance of social media to language development and societal conditions. Language material is of great value to the humanities, but also to the social and natural sciences, including health sciences. Societal changes can be studied using various kinds of language data and there is an increasing research interest in, for example, the links between language and neuroscience. The long tradition of language infrastructures in Sweden and the fact that Swedish language infrastructures are now integrated into European infrastructures forms a foundation on which to build.

In a unified national infrastructure for language data, it could be possible to include structured data for speech technology and speech research, historical text material and various other kinds of digitised material such as books or social media.

Expected impact: The potential for new breakthroughs in language research will be enhanced by making new data from various kinds of language materials accessible for research. The potential for breakthroughs in other fields of research will also be substantially improved by widening the infrastructure to include more texts and other language material. It is expected that only a national infrastructure that includes a wide set of existing databases will be able to deliver the desired outcomes, but this would require the coordination of various actors in this field of research.

In this area, the following infrastructures for which the grant period ends in 2017–2018 are currently funded by the Swedish Research Council:

SWE-CLARIN
CLARIN-ERIC

Infrastructure for metabolomics

Challenge: Metabolomics addresses fundamental biological questions and is used in personalised medicine research, biomarker and target identification, therapy, diagnostics and metabolic network constructions.

The challenge for this research area is how to expand and improve the library of small molecules that are used to determine basic biological mechanisms and to generate disease markers and diagnostic methods for diseases like cancer, neurology and diabetes. The user demand is increasing in terms of both user time and hands-on knowledge.

Description: Laboratories generate small organic molecules (metabolites) and genome-related data. These metabolites are considered to be closer to the phenotype and therefore provide information that can be translated and linked to particular phenotypes. Metabolomic data is essential in order to fully understand biological processes and mechanisms.

Metabolomics, also known as metabonomics or metabolite profiling, is now an integral component of biological and medical research. The methods and technologies applied to different types of biological samples are similar but not identical. Today, there are various specialised laboratories set up as platforms at Swedish universities.

Metabolomics has the potential to strengthen research in several life sciences disciplines. In order to achieve this and to expand and improve the small molecule library, primarily for NMR (nuclear magnetic resonance), but also for other technologies such as mass spectrometry, it will be necessary to align and consolidate resources within this area. Integration of platforms could also lead to the establishment of new procedures for determining biological mechanisms, metabolomic patterns of disease and diagnosis. Interactions between the different platforms, including NMR for Life and SciLifeLab, must be improved.

Expected impact: A national infrastructure for metabolomics encompassing applied technologies, methods, expertise and opportunities to combine data related to metabolomics, resulting in an increased numbers of identified metabolites. This is expected to improve diagnosis and the surveillance of treatments for diseases.

Infrastructure for animal experiments using small animals

Challenge: The use of small experimental animals (rodents and lagomorphs) is crucial to research in medicine and health, molecular and cellular biology and also environmental sciences. It will continue to have a significant impact on academic research and future solutions to societal challenges. There are a large number of users and techniques are constantly being refined and becoming more sophisticated. At the same time, small animal experiments are technically demanding and expensive. Moreover, and ever more importantly, using small animals for experimental research can be controversial and will be accepted in society only if the use of animals is undertaken in accordance with high standards in terms of research quality, there is low risk of inflicting suffering on individual animals and transparent professional processes for ethical approval are used.

Description: The establishment of a coordinated national infrastructure for small animals would benefit research in a wide range of life sciences. Such an infrastructure has to involve several different types of small laboratory animal models. In addition, a laboratory animal research infrastructure must encompass training in order to ensure a high international standard.

Today, most Swedish universities rely to a large extent on in-house infrastructure for laboratory animal research; however, the local portfolio of services is often not able to meet the demands placed on it. It is important to develop a national standard for the care and use of laboratory animals including opportunities to perform GLP (good laboratory practice) studies. A national infrastructure would make existing resources available to all academic organisations, as well as to industry.

Expected impact: A national infrastructure for small laboratory animals would service the need for national standards for the care and use of laboratory animals. All Swedish universities with significant experimental facilities for small animals should be involved. The proposed infrastructure is expected to increase accessibility and interoperability, to improve the services provided to research communities and to facilitate a widening of the user community. A national infrastructure for small laboratory animals is important in order to ensure there is strong basic and applied research that is relevant to universities, the life sciences industry and the healthcare sector. It would also allow animal models to be shared within and between different facilities and would increase the possibility of backing up unique animal strains.

Instrumentation for the European Extremely Large Telescope, E-ELT

Challenges: The aim of astronomical research conducted using the E-ELT is to observe and understand our universe, its origin and evolution. This encompasses everything outside of the earth's atmosphere – from objects in our solar system, out to the very beginnings of the universe itself. This goal is motivated by the human race's desire to explore our surroundings and the edges of our own existence, as well as by our need to understand where we come from and where we are heading.

The emissions emanating from the objects in space are faint and are also dampened by the earth's atmosphere. High spatial resolution is required because of the vast distances between the earth and the objects

being studied. Naturally, this places very demanding requirements on both the design of telescopes (for light collection) and the instrumentation used to receive and discern signals.

Description: The development of the E-ELT is being conducted by the European Southern Observatory (ESO). The telescope will be built in Chile and will be the largest optical/near-infrared astronomical telescope in the world, with 13 times more light-collecting capacity than the largest optical telescopes in existence today. The potential of the E-ELT is crucially dependent on the instrumentation developed for it, and the extent to which Swedish researchers are able to be at the forefront with early ground-breaking research is greatly dependent on their involvement in the specifications and design of such instruments. As the instruments required are very complex, large international consortia are needed in order to develop them.

Expected outcome: Participating in the instrumentation for the E-ELT would enable Sweden to take full advantage of its potential. The E-ELT is expected to revolutionise many current branches of astrophysics, including planetary formation, the evolution and stellar populations of our galaxy, the early epochs of galaxy formation and the evolution of the large-scale structure of the universe. Joining in with the development of instrumentation would allow Swedish researchers to get detailed insights into the design and characteristics of the instrumentation and put them in a good position to take advantage of it in early observations, both using guaranteed time for the consortium and open-time observations. Swedish industry could also benefit from taking part in this technologically challenging project and be better placed to engage in similar future projects.

DESIREE: storage ring infrastructure for atomic, molecular and chemical physics

Challenges: The aim of research in this area is to study atomic, molecular and cluster processes under conditions that are controlled with respect to temperature, internal excitation energy and relative collision energy. This is motivated by a desire to study fundamental atomic and molecular physics, as well as the possibility of recreating astrophysical conditions as an environment in which to study various processes that govern molecular creation and destruction in the universe. The main obstacles are achieving cryogenic conditions and adequate storage times that allow relaxation and controlled excitations and collisions between individual pairs of stored ions at low energies.

Description: Research in this area is focused on the inherent stabilities of slowly decaying atomic, molecular or cluster cations or anions; photo-absorption spectroscopy of internally cold ions; reactions between individual pairs of cations and anions from keV to MeV collision energies; fragmentation and bond-forming reactions and properties of biomolecular systems.

This takes place at the DESIREE facility, a double electrostatic ion storage ring that operates under cryogenic conditions, offering the opportunity to perform merging ion-ion collision experiments between negative and positive ions. The results include storing a cooled beam of negative sulphur ions, permitting long lifetime measurement of an excited state in a negatively charged ion, the demonstration of quantum-state resolved electron transfer reactions between internally cold pairs of positively and negatively charged stored ions at sub-eV energies and the demonstration of a nearly pure beam of molecular anions in their rotational ground state.

Future challenges for the infrastructure are to improve the techniques and instrumentation further. For example, techniques could be developed for the injection of complex and fragile ions such as bio-molecular ions and complex ions of astrophysical interest in well-controlled quantum states into the storage rings. Making merged-beams experiments possible between stored ions and neutral atoms and molecules is of particular interest to astrophysics.

Expected impact: DESIREE will offer users the opportunity to perform ground-breaking experiments in atomic, molecular, cluster and chemical physics. In addition to fundamental research within these fields, it will also make it possible to perform experiments with applications in astrophysics, astrochemistry and atmospheric science, as well as in environmental physics and biomolecular physics.

2.2 Relevant to be considered as infrastructure of national interest, not mature enough for the call for proposals 2017 – A2

Future solar telescopes with advanced instrumentation

Challenges: Understanding the sun is vital; this star can be observed at a level of detail orders of magnitude better than any other and has a bearing on many aspects of science on earth in fields such as geophysics, climatology, astrophysics, biology, etc. The leading questions are: i) what does the sun teach us about fundamental astrophysics, ii) what drives solar variability and iii) what is the origin of space weather? Common to all aspects is a need to understand and constrain by observations the rapidly changing magnetic field of the sun and its interaction with the solar matter and radiation.

Description: The focus of solar physics is on understanding the outer atmospheric layers of the sun such as the photosphere and chromosphere. Observations are carried out using ground-based telescopes, as well as space probes and satellites. Ground-based telescopes have, by being much bigger than those in space, the advantage of enabling a smaller theoretical image size, i.e. a better spatial resolution. However, the image degradation caused by turbulence in the earth's atmosphere must be corrected using adaptive optics. A larger telescope also collects solar photons at a higher rate, enabling more precise polarimetric measurements of magnetic fields.

The European Solar Telescope (EST), which is on the ESFRI roadmap, is a planned next-generation optical telescope for solar physics that is to be located on the Canary Islands. The EST is designed to have a primary mirror diameter of about 4 m, leading to an improvement in the theoretical spatial resolution by a factor of 4 and in the light collecting area by a factor of 16 compared to the current Swedish Solar Telescope (SST).

The EST will enable solar physics at the forefront of science and will provide significant help in advancing our understanding of how the output of radiation and particles from the sun, and variations in this, affect life on earth. If Sweden is to maintain its strong position in solar physics, it is necessary to consider participation in the planning and construction of EST. However, there are many uncertainties that first need to be assessed.

Infrastructure for archaeology

Challenge: Archaeological research has the potential to enhance our understanding of not only human societies of the past, but also those of the present day. It is of critical importance here to integrate different perspectives from the natural sciences with those from the humanities. Appropriate infrastructure and coordinated efforts by the Swedish research community are required if this is to bear fruit. The establishment of a national infrastructure could serve as vehicle with which to establish and sustain such processes.

Description: Research methods of relevance to archaeological research have seen a rapid development in recent years and archaeologists are collaborating in several disciplines and with various actors (for example SciLifeLab). Archaeological research often involves expensive instruments, which justifies the coordination of the use of such resources. Aggregated access to multiple and disparate sources can facilitate the large-scale analysis of an increasing number of research questions. Archaeological data is potentially of strategic importance to meeting future challenges such as climate change, health and agricultural development. However, a cutting edge platform is needed in order to meet these challenges. Therefore, there could be great potential in linking up the existing Swedish archaeological resource labs to form a national infrastructure. It is important to provide a good structure for the processing/analysis of data, facilities, equipment and skills required, which an individual lab could not provide. Furthermore, it appears to be important to coordinate existing archaeological databases, situated at different universities, in a common framework in which different sources of information could be linked.

Infrastructure for clinical and preclinical bioimaging

Challenge: Bioimaging has a great impact on and is essential to both clinical and preclinical research. Imaging is of importance to neuroscience, neurology, cardiology, oncology, metabolic diseases and pharmacodynamics.

One challenge for Swedish research lies in generating and maintaining state of the art equipment and expertise in various locations in Sweden in order to ensure that there is clinical and preclinical progression and that new diagnostic procedures are developed.

Description: Clinical bioimaging includes techniques such as computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), single-photon emission computed tomography (SPECT) and magnetoencephalography (MEG). This field has recently experienced major technological developments such as improved resolution, functional contrast and novel tracer molecules. These technical achievements could be further improved by integrating different platforms in order to combine results and share knowledge. It is also important to make the existing equipment available domestically to all users.

Integration of some or all of the aforementioned technologies and expertise, as well as others, into a national infrastructure has the potential to increase the scientific interchange and thus accelerate the elucidation of mechanisms of human, animal and organ functions. In order to fulfil the criteria of a national infrastructure, interaction between the different platforms has to be improved and a governance structure has to be implemented. In the longer term, interaction with Euro-Bioimaging could strengthen the infrastructure. These methods all require excellent e-infrastructure which should also be managed jointly by the proposed infrastructure.

Infrastructure for controlled plant experiments

Challenge: Successful basic and applied experimental plant research is of fundamental importance to addressing the global challenges posed by increasing demands for food, fibre and other plant-derived products under the pressure of global change and other environmental impacts. Thanks to achievements in molecular biology and genomic technologies, plant researchers have learned more about the genetics underlying the development, productivity and stress tolerance of various model and crop/tree species. In addition, there is increasing recognition of the complex interaction between the genotype and its environment as evidenced by the phenotypic plasticity of plants in response to light, temperature, water, nutrients and other abiotic and biotic factors. Cutting-edge plant cultivation facilities with controlled environments and multiple options for precisely defined treatments, including confined experiments with genetically modified plants, are indispensable to the future development of plant biology research.

Description: An infrastructure for the coordination of advanced plant facilities in which controlled experiments with multiple options can be performed. Sweden already has a great output in terms of research results from existing facilities. The continued development of advanced facilities for experimental plant research to form a network that is open to all research groups is likely to increase Sweden's scientific output in the field of plant science. It can also support research in environmental sciences and other related areas. However, in order to become established as a national infrastructure, the added value of this must be well elucidated, including appropriate and concrete information about the involvement of the partner universities.

Infrastructure for coordination of aerosol measurements

Challenge: Atmospheric aerosols are formed by a wide range of natural processes and anthropogenic activities. They play an important role in air pollution and related health issues. Moreover, they have major effects on the global climate through their influence on cloud formation and the earth's radiative balance. These relationships are complex and difficult to quantify on the basis of current knowledge. The coordination of aerosol observations and data on a national and global scale is therefore vital in order to gain a better understanding of air quality and climate development. In a European perspective, the research infrastructure project ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure network) has been included in the ESRFI roadmap in 2016 as an initiative to consolidate European activities involving the observation of aerosols, clouds and trace gases.

Description: A Swedish ACTRIS would complement existing infrastructures such as ICOS and SITES, enhancing our understanding of the interaction between ecosystems and the atmosphere. In particular, ACTRIS would add vital information about atmospheric aerosols, gases and clouds to the hydrological, meteorological and ecological analysis of greenhouse gas fluxes and concentrations. In this way, a full set of parameters

describing the land-ocean-ecosystem-atmosphere system can be obtained, including aerosol-induced climate effects such as light scattering, light absorption and cloud formation. Explanations of the added value to research of the specific hardware and software facilities proposed are needed in order to justify a national infrastructure in this area. It will also be necessary to demonstrate the involvement of an appropriate national research community. The relationship to ICOS and SITES, including the impact on logistics and scientific synergies, should be clearly described.

Infrastructure for experimental and long-term studies of geosphere processes

Challenge: The subsurface of the earth, the geosphere, is slowly but steadily changing due to natural physical, chemical and biological processes, as well as the exploitation of minerals and materials and underground spaces. There is a scarcity of direct observations of these complex processes at depth. High quality experimental and observational long-term data in three-dimensions are necessary, not only for basic research into geological evolution, the deep biosphere and natural hazards, but also for practical industrial applications such as mining, underground construction, geothermal energy and nuclear waste disposal. Coordinated management in order to fully exploit existing facilities has a great potential to enhance Swedish research and thus preserve Sweden's leading position in terms of basic research and the sustainable exploitation of the earth's crust and the resources it provides.

Description: Only underground constructions or drilling can give direct access to the subsurface. Although dedicated underground laboratories are very expensive, they allow the sophisticated observation of structures and short and long-term processes and their interactions, from the surface to depth. Drilling is less expensive, can penetrate to greater depths and thus allows larger and deeper areas to be sampled. The two approaches are therefore complementary. Modern earth science is based on multidisciplinary approaches that use sophisticated measurements at and close to the surface and at depth, laboratory measurements, database systems and analytical tools. This is highlighted by the ongoing EPOS European ESFRI infrastructure initiative in which Sweden is participating. The Swedish research community in this area should explore the feasibility of collaborating in the creation of a well-structured distributed research infrastructure and database system for underground three-dimensional geosphere studies.

Infrastructure for historical databases

Challenge: Direct observation of history is of course not possible. The organisation of historical archival data in the form of accessible infrastructures is therefore of great value. The existing infrastructures, which primarily contain demographic data, illustrate the fantastic potential of such facilities to sustain world-class research, not only by Swedish scholars, but also by international researchers. The challenge lies in promoting more internationally leading research by extending infrastructures to cover new areas and filling the gaps in those that already exist.

Description: Sweden has unique historical sources that are preserved and thus potentially valuable assets for research. The historical archives include information about individuals, as well as about various kinds of aggregates ranging from households, parishes, municipalities and regions, to the nation state. National infrastructures already exist in the form of historical databases concerning what is usually labelled demography. In practice, these data can be used to enhance a whole range of other disciplines, ranging from economics to health-related studies. However, gaps remain in terms of certain time periods and there is a potential to coordinate access to databases with various geographical focuses and in various locations. By using variation over time, research into a range of economic issues, for example inequality, has benefitted from the establishment of aggregated data with very long time series. The use of variation between various geographical/administrative subdivisions also has great potential. A national infrastructure that facilitates collaboration in the collection of data and makes different kinds of data accessible and linkable by both the domestic and international research communities could be a valuable asset.

Infrastructure for livestock research

Challenge: Translational research has shown that rodents and lagomorphs have limitations as models for human medical research. Together with advancements in molecular biology, there has been a partial loss of knowledge about the use of whole animal studies as a tool in medical research. The use of livestock models in medical research could play an important role in the future of translational research.

Another aspect of livestock research is the need for improved animal production and a positive direction in terms of profitability, animal welfare and acceptance of the environmental impact of farming activities by the wider community.

Description: There is a demand for access to livestock models both at universities and in industry. National expertise in the field of veterinary medicine and animal science with respect to animal health and husbandry, as well as in the field of comparative and translational research is currently concentrated at the Swedish University of Agricultural Sciences (SLU).

Even if there are strong arguments in favour of and demands for a national infrastructure for livestock research, more comprehensive studies are needed in order to identify and specify the national setting. Such an infrastructure would have to involve several types of animal models and ensure an internationally high standard. Moreover, a national infrastructure must also encompass training. It will be important to clarify what is to be covered by a national infrastructure and what is to be undertaken by SLU within its responsibility for research and education. It is also important to clarify how a national infrastructure would incorporate research into how livestock and animal welfare relates to food production and the environment.

Infrastructure for macro context databases

Challenge: The social sciences are concerned with for example analysing the consequences of various kinds of social, political, economic and environmental structures or contexts for the conditions, values and behaviours of individuals. These contexts range from global to local factors and include structures that can be changed, as well as factors that are very difficult to manipulate. Different and changing contexts offer great opportunities for systematic analysis of the implications of, for example, policy changes.

Description: Swedish researchers have successfully built up databases that can be seen as national and international infrastructures for contextual information about, primarily, nation states. In terms of data, we can observe a broad range of contextual information, from armed conflict and corruption to quality of government and social protection. The range of the databases also vary in terms of the time periods and number/categories of countries covered, ranging from global coverage to coverage of countries that are very similar to Sweden. The research requirements are immense in terms of systematic information about contextual factors at different levels. New theories demand information about a broad set of factors. There is great potential for the coordination of collection and linkages between different existing databases in order to create synergies and facilitate ground-breaking research. This is true for issues relating to global challenges, for example those expressed in the Sustainable Development Goals (SDG), for EU member states, which may be regarded as a laboratory, and for regional subdivisions where policy interventions and other contextual factors may also vary.

Infrastructure for protein research

Challenge: Proteins are central to life sciences research as they have a multitude of functions in all organisms and because most drugs currently on the market act on them. The need for a national infrastructure for protein production and mass cytometry has been identified.

Structural biology in Sweden is a prominent field of research that is expected to develop further thanks to the next generation synchrotron MAX IV, the spallation neutron facility ESS, and the platforms Cryo-EM and NMR for Life. A prerequisite for protein studies using these platforms is the availability of defined pure proteins and tailored protein motifs. The challenge today lies in matching the increasing demand with diversified protein production of a high quality. A national infrastructure for protein production with specialist expertise in the required areas would therefore strengthen life sciences in Sweden.

Single-cell analyses of different kinds are increasingly important to biological and medical research. The challenge lies in tracing individual cell linages for the study of embryology, cancer, stem cells/regenerative medicine and even infectious agents. Thus far, the main focus has been on genomics and transcriptomics of

single cells as it has been difficult to study proteomics from individual cells. Information about protein expression is necessary in order to understand the biology of cells.

Description: There are several existing platforms for protein production, each of which specialises in a certain area: bacterial protein production, eukaryotic protein production and the production of protein in insect cells. These platforms are distributed at sites that are often close to the analytical platforms and the integration of the protein production platforms has already been initiated; however, this needs to be formalised. The purpose of the integration is to meet the increasing requirements for protein production in order to strengthen the analytical platforms and drug development platforms. This could benefit a wide spectrum of life sciences research and potentially deliver new mechanisms, new ideas for drugs and new diagnostic procedures. However, further clarification is needed with regard to the added value of integrating the protein production platforms, suitable governance, appropriate solutions for e-infrastructure and links to industry, as well as how protein production could strengthen research.

Through mass cytometry, it is has recently become possible to study proteomics, including protein interactions from single cells. The current facility is the only one available in Sweden and the scientific impact of this technology is expected to be large for several fields. In addition, there is the potential for a multitude of industrial applications, including diagnostic tools based on biomarkers.

Infrastructure for drug development

Challenge: The focus of an infrastructure for drug development is to develop small organic molecules (currently undertaken by Chemical Biology Consortium Sweden, CBCS), proteins and antibodies (currently undertaken by the Drug Discovery and Development platform, DDD) for use in studies of mechanisms in eukaryotes and plants and for the development of new drugs (CBCS and DDD). An extensive and well characterised library of small molecules along with the potential to produce proteins and antibodies are prerequisites for these activities.

Description: The current infrastructures have generated large libraries of compounds and screening methods in order to identify biological activities in the testing systems and biological models included in users' projects. Biologically active compounds are optimised and characterised with respect to parameters that are important to biological experiments in animal models, for example membrane permeability and metabolic stability. Expertise is provided within the fields of assay development, computational chemistry, cheminformatics, chemical library screening and development, medicinal/enabling chemistry, target identification and preclinical profiling. The platforms are included in SciLifeLab as a distributed infrastructure with units in Stockholm, Uppsala and Umeå. In order to fulfil the requirements of a national infrastructure, interactions between the nodes should be strengthened and coordinated in order to produce services for researchers throughout Sweden.

Infrastructure for regenerative medicine

Challenge: The field of regenerative medicine has the potential to revolutionise medicine by addressing important issues in the fields of cell biology, developmental biology and tissue regeneration. Translational regenerative medicine, including gene and cell therapy, is of paramount importance to clinical development. There is the potential to treat a variety of diseases and injuries using stem cells. A platform that is focused on research could help bring the expertise in the field together in a collaborative effort that could achieve the critical mass required in order to attain key goals, for example clinical proofs of concept.

Description: An infrastructure for regenerative medicine would be used by researchers developing new treatments in the field of gene therapy and cell therapy, including immune therapy and tissue engineering. Implementation of these treatments in the public healthcare system will require access to advanced cleanroom facilities for manufacturing clinical grade products in accordance with Good Manufacturing Practice (GMP). Current legislation also imposes strict requirements on traceability, raw materials, staff, equipment, documentation and facilities.

As a part of the project Vävnadsprojektet (2008–2017), cleanroom facilities for manufacturing cells and tissues were built at several university hospitals. Operational infrastructures are located in Gothenburg, Linköping, Stockholm and Uppsala. They have been essential to the development of advanced therapy

medicinal products (ATMPs) and cells for transplantation in Sweden and have been instrumental in carrying out world-class clinical translational research. Manufacturing of ATMPs in accordance with GMP is often an activity that is somewhere in between basic research, clinical use and industrial production and thus requires knowledge and expertise that is at the forefront of science, as well as a very strict adherence to ethical guidelines.

The continued development of Swedish research in this area requires coordination between the cleanroom facilities at Swedish university hospitals. This will facilitate the development of novel therapeutic methods.

Infrastructure for visualisation

Challenges: Increasing volumes of data from various sources have brought about a need for effective analysis so that scientists are able to better understand the meaning of the data and derive knowledge from it. The data can originate from simulations, laboratories, empirical experiments, surveys, register data or archives. The data can come from a number of application domains such as geodata, medical imaging, design sciences, material development, meteorology, astronomy, geography, archaeology, history and motion capture from rehabilitation. The output of the analysis needs to be multifaceted and include patterns, abstract relationships and the development of phenomena over time and space. Because the data, users, providers and experts in the application of visualisation will be distributed among different organisations, it is vital that access to and provision of visualisation is ubiquitous. Furthermore, as users will include both novices and experts, good utility, usability and user support are of the utmost importance.

Description: Visualisation includes the processing of the data and its presentation to users in the form of, for example, graphs, diagrams, maps, images, animations and virtual reality. This helps scientists understand vast and complex data that comes from different disciplines. Improved hardware and software systems and open data have given rise to the growth of the field of visualisation. Although there are individual centres of expertise with equipment for visualisation, few offer visualisation and expert support as a research tool to users in a wide range of disciplines

Distributed centres can form an integrated infrastructure for the provision of visualisation services for scientists. These centres can specialise in application domains. The organisation would create synergies between centres so that knowledge is transferred within the distributed infrastructure. The infrastructure should provide different levels of access to user services in a transparent way, depending on the support and expertise required. It is predicted that the infrastructure will also stimulate scientists' awareness of visualisation as a research tool.

Collaboration with existing infrastructures, including e-infrastructures, is fundamental to the establishment of an infrastructure in this area.

3 RESEARCH INFRASTRUCTURE CURRENTLY FUNDED THAT IS ELIGIBLE FOR THE INFRASTRUCTURE CALL 2017[3]

Infrastructures that are currently funded by the Swedish Research Council for which the grant period ends in 2017 or 2018 are described in the following section. This does not exclude the possibility that other infrastructures, with or without funding from the Research Council, may be included in a proposed infrastructure within the thematic area in question. The Research Council's aim is to describe the challenges and expected impact for each infrastructure or thematic area, but not a definitive solution. It is up to the partners attempting to organise the infrastructure to describe what specific infrastructure is needed and whether an area best is served by one, two or more infrastructures.

Biobanking and Biomolecular Resources Research Infrastructure, BBMRI-ERIC[4]

The Biobanking and Biomolecular Resources Research Infrastructure (BBMRI-ERIC) is a joint organisation for biobanks in 19 European countries that was set up in 2013. The goal is to make biological samples easily accessible to the health services research and development community and to highlight Europe's collective resources from a global perspective. Through its various nodes in all the member countries, the infrastructure covers a large and varied supply of well-characterised biological samples. This is expected to increase the value of the sample collections and improve the feasibility of large international collaborations. Within the framework of BBMRI-ERIC, the member countries are funding a coordinating head office, along with a few common services. The Swedish node is involved in the operation of the common service for Ethical, Legal and Societal issues (ELSI).

Common Language Resources and Technology Infrastructure, SWE-CLARIN and CLARIN-ERIC[5]

CLARIN is a distributed infrastructure based on a network of national centres offering data, processing services and expertise to the research community. Typical sites are universities, research institutions, libraries and public archives. The purpose of CLARIN is to serve as a research infrastructure (e-sciences for humanities, social sciences and educational sciences) that is based on language resources and uses language technology tools that can be used in all disciplines in which language data is analysed (e.g. history, law and psychology). This involves not only data resources in the form of text and audio archives, corpuses (collections of language data), historical sources, newspapers, dictionaries, grammar, etc., but also the technologies and tools needed to store, distribute and process the data resources. The "Knowledge Sharing Infrastructure" is another part of CLARIN's mission. SWE-CLARIN is a Swedish node in the European infrastructure CLARIN-ERIC.

Consortium of European Social Science Data Archives, CESSDA

CESSDA is a collection of European social sciences data archives and a distributed infrastructure for social sciences data. The consortium is organised as a distributed infrastructure in which each member, represented by a national research authority, has a designated Service Provider that meets specific demands and requirements specified in the Statutes. Since its establishment in 1976, CESSDA has served as an informal umbrella organisation for the European national data archives. Through CESSDA, researchers gain access to data from European countries and Swedish researchers also gain access to data from a large number of countries outside

[3] Either on its own or, when applicable, as part of one of the thematic areas described under A1.

[4] In order to apply for research infrastructure grants, this infrastructure should be included in the A1 thematic area "Coordination of biobanks and associated data".

[5] In order to apply for research infrastructure grants, this infrastructure should be included in the A1 thematic area "Infrastructure for research based on language data".

Europe via the organisation's participation in global data collaborations. Since June 2013, CESSDA has been operating as a Norwegian limited liability company (CESSDA AS), but is due to be transformed into an ERIC in 2017. There are currently fifteen member countries. Sweden's service provider is the Swedish National Data Service (SND).

Evaluation Through Follow-up, ETF/UGU[6]

Evaluation Through Follow-up (ETF, Swedish acronym UGU) is the only infrastructure of its kind in Sweden within the field of education and is also one of the oldest social sciences databases in the country. While the initial purpose was to evaluate the national school system, it has become an important infrastructure for researchers within other areas of the social sciences. So far, nine follow up studies based on large and nationally representative random samples from different pupil age groups have been initiated. The first empirical data collection was carried out in 1961. Administrative data and survey information is collected for each random sample.

European Social Survey, ESS-S and ESS-ERIC[7]

ESS is a social sciences and sociological survey on attitudes and behaviours. Since the survey began in 2002, it has been conducted seven times in more than 30 European countries, including Sweden. The infrastructure has three overall aims: to monitor and explain the interaction between the changing social structures and attitudes in Europe and the ideas and behaviours of its culturally and socially varied populations; to facilitate the comparability of surveys across borders and language barriers; and to develop and implement social indicators in parallel to the frequently used economic indicators.

Experiments and WLCG at CERN

WLCG (The Worldwide LHC Computing Grid) is a distributed computing infrastructure that provides the production and analysis environments for the Large Hadron Collider (LHC) experiments at the European Organization for Nuclear Research (CERN). WLCG is managed and operated by a worldwide collaboration between the experiments and the participating computer centres, currently more than 170 in 36 countries, that process, analyse and store data produced by the LHC. The Swedish contribution is managed by the Swedish National Infrastructure for Computing (SNIC).
Swedish research groups are involved in the ALICE, ATLAS and ISOLDE experiments at CERN. Costs connected to the participation in the experiments include costs for upgrades and for maintenance and operations (M&O).

IceCube Neutrino Observatory

The world's leading neutrino telescope, the IceCube Neutrino Observatory, consists of light-sensitive detectors with a volume of one cubic kilometre placed deep in the Antarctic ice. The central goal of this observatory is to study high-energy neutrinos – a type of elementary particles that are difficult to detect – from space and their astrophysical sources. Neutrino oscillations are also studied with the help of atmospheric neutrinos. IceCube has recently detected the first high-energy cosmic neutrinos. Belgium, Sweden, Germany and the United States started IceCube and at present, twelve countries are participating. The four founding countries monitor the project through a control group in which the Swedish Research Council is represented.

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[6] In order to apply for research infrastructure grants, this infrastructure should be included in the A1 thematic area "Infrastructure for research based on individual level databases in medicine and the social sciences".

[7] In order to apply for research infrastructure grants, this infrastructure should be included in the A1 thematic area "Infrastructure for research based on individual level databases in medicine and the social sciences".

Institute for Solar Physics, ISF

The focus of solar physics research is on understanding the structure and dynamics of the sun's atmosphere, which is important for astrophysics, as well as a wide range of other disciplines such as geophysics, climate research, space physics and biology. Solar physics research requires access to either ground-based telescopes or space probes and satellites.

The best resolving optical solar telescope today is the ground-based Swedish Solar Telescope (SST) on the Canary Island of La Palma. It is run by the Institute for Solar Physics (ISF), a national infrastructure hosted by Stockholm University. The SST is expected to remain a world-leading facility in the near future, until its capabilities are surpassed by the next generation of solar telescopes, the planned European Solar Telescope (EST, see description under A2) and its American competitor DKIST.

International Social Survey Program, ISSP[8]

The International Social Survey Program (ISSP) is a researcher-governed comparative project with the task of constructing and implementing internationally comparable attitude surveys. The comparative database that has been built contains data concerning a variety of different attitude areas that have been collected annually since 1985. Over forty countries are currently involved in ISSP, the data of which are freely available to the research community. The investigations also have a clear theoretical framework of a more general nature. Thanks to the long-term construction, the ISSP database now constitutes an essential part of the research community infrastructure.

Ion Technology Centre, ITC

The Ion Technology Centre was established in year 2000. The centre contains resources – competence and equipment – from several Swedish universities and engineering colleges. The centre is meant to be a national resource and give access to material analyses and ion implantation services to users from universities, institutes and industry. The centre is located at Uppsala University, the Ångström laboratory. The Ion Technology Centre has a steering group with representatives from Uppsala University, the Royal Institute for Technology, Linköping University, Chalmers, the Faculty of Engineering at LTH and industry.

National Bioinformatics Infrastructure Sweden, NBIS, and ELIXIR[9]

NBIS is a distributed research infrastructure providing bioinformatics support to life sciences researchers in Sweden. The majority of activities focus on bioinformatics support within DNA and RNA sequencing projects, but NBIS also provides support within proteomics, genetic networks, metabolomics and, on a smaller scale, systems biology. The infrastructure offers access to a number of tools (software, algorithms), as well as associated user support and training. NBIS is the Swedish contact point for the European bioinformatics infrastructure ELIXIR.

National Genomics Infrastructure, NGI

NGI gives Swedish researchers access to the latest technology for large-scale DNA sequencing. Large-scale analysis of DNA and RNA sequences plays a central role within biomedical research.

NGI is one of the three largest genomics centres in Europe and thanks to its location at SciLifeLab in Stockholm and Uppsala, it can make use of shared equipment and expertise. NGI collaborates with two other national infrastructures: NBIS within bioinformatics and SNIC when it comes to data analysis and storage. NGI offers expertise within bioinformatics and statistics in order to ensure optimal experimental design and academically productive projects. The consulting role of NGI is one of the infrastructure's main tasks.

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[8] In order to apply for research infrastructure grants, this infrastructure should be included in the A1 thematic area "Infrastructure for research based on individual level databases in medicine and the social sciences".

[9] In order to apply for research infrastructure grants, this infrastructure should be included in the A1 thematic area "Infrastructure for bioinformatics".

National platform for scientific drilling – Riksriggen

Riksriggen is a drilling rig for scientific investigations of the earth's crust, down to a depth of 2.5 kilometres. Important research questions that can be studied using deep core drilling include the geological development of the bedrock, life deep in the rock, large-scale groundwater systems and calibration of climate models through temperature measurements. In addition to basic research, the rig can be used for applied projects such as studies of the potential for geothermal energy extraction and geological storage of carbon dioxide. Extensive preparatory studies are required before deep drilling takes place. These primarily concern the geophysical conditions for optimal placement of the borehole, but also involve planning the drilling itself and the scientific work at the drill site. Sweden is participating in two large international scientific drilling consortia: the deep sea drilling programme Integrated Ocean Drilling Programme (IODP) through its European branch ECORD, and the ICDP, which is the land-based equivalent.

Onsala Space Observatory, OSO

OSO is a Swedish national facility hosted by Chalmers University. The observatory constructs and operates astronomical and geodetic infrastructures, both on site in Onsala and internationally. This includes local antennas used in stand-alone mode or for interferometry, user support functions, participation in international radio astronomy projects and advanced instrument development.

The radio astronomy research at OSO is mainly focused on studies of the interstellar medium and its fundamental importance for the development of the universe – from planetary systems to cosmology. The geodetic research is focused on frames of reference and the earth's rotation and gravitational field, variations in the composition of the atmosphere and sea level measurements.

Polaris and HRPD at ISIS

Sweden is a member of the British neutron source ISIS. Sweden participates in two of the instrument development projects at the facility: the diffractometers Polaris and HRPD. Polaris is a high intensity instrument that enables structural studies with rapid data collection (e.g. kinetic studies), experiments where only small amounts of material are available, and the study of materials under non-ambient conditions and disordered materials. HRPD is a high resolution neutron powder diffractometer with the best resolution for this kind of instrument, which enables studies of fine structural details in complex crystalline materials with large unit cells and small structural changes at phase transitions. The project is led by Chalmers University of Technology.

SuperADAM at ILL

Sweden is a member to the European neutron facility Institut Laue-Langevin (ILL). A neutron reflectometer at the facility, SuperADAM, is operated by Uppsala University. The instrument is an angle dispersive fixed wavelength instrument with horizontal scattering geometry. It has two operation modes; a high flux option, mainly dedicated for soft matter research, and a lower flux option/high resolution mode, especially suitable for measurements on magnetic materials, with the opportunity to conduct accurate polarisation analysis. SuperADAM can be used to investigate the in-plane average structure of thin films in the range of a few nanometres to hundreds of nanometres and to reveal the depth distribution of light elements in thin films, polymer interfaces and solid/liquid interfaces, and the depth resolved magnetic structure of thin films.

The Survey of Health, Ageing and Retirement in Europe, SHARE-S and SHARE-ERIC[10]

SHARE is an interdisciplinary interview survey on health, ageing and retirement in Europe that has been carried out in 21 countries, including Sweden, since 2002. The purpose of SHARE is to improve our

[10] In order to apply for research infrastructure grants, this infrastructure should be included in the A1 thematic area "Infrastructure for research based on individual level databases in medicine and the social sciences".

understanding of the consequences of demographic ageing. The survey focuses on aspects including labour supply, maintenance, social and financial circumstances, family networks and physical and mental health. The SHARE survey includes around 90,000 individuals over the age of 50 and the plan is to conduct 10 rounds up until 2024. At the European level, SHARE is led by the Munich Center for the Economics of Ageing (MEA) at the Max Planck Institute for Social Law and Social Policy. Swedish SHARE is run by Umeå University, the Centre for Population Studies and the Department of Sociology. SHARE-S is a Swedish node in the European infrastructure SHARE-ERIC.

Swedish Infrastructure for Ecosystem Science, SITES

SITES is a newly established, distributed research infrastructure that coordinates a number (presently nine) of Sweden's field stations for land-based climate, environment and ecosystem research. The purpose of SITES is to offer researchers at all of the country's higher education institutions and research institutes well-functioning and openly available infrastructures for field-based research. Together, the stations cover widely different nature types and climate zones, from agricultural landscapes, forests, mountain areas and wetlands, to various types of inland waters.

Swedish Longitudinal Occupational Survey of Health, SLOSH[11]

SLOSH is a longitudinal study investigating the connection between labour market participation, working environment, retirement and health. The study is expected to contribute to better conditions for a healthy life and increased knowledge of how the risks of morbidity and illness can be reduced both in and outside of working life. The intention is for the infrastructure to study the complex relationship between labour organisation, working environment, labour market participation and health. SLOSH is based on the 2003, 2005 and, in part, 2007 labour market surveys (AMU).

Swedish Mammography Cohort, SMC[12]

SMC is an extensive population-based follow-up study of over 60,000 women in the counties of Västmanland and Uppsala. The intention is for the study to look at the relationship between a number of lifestyle indicators (including diet, vitamin supplements, physical activity, smoking, alcohol and weight) and the incidence of a number of chronic diseases. The longitudinal design of the infrastructure and the access to updated exposure data for the cohort makes it possible to consider changes in lifestyle factors that may influence the risk of various diseases. Follow-up of the cohort is also managed through registers.

Swedish National Data Service, SND

SND is a national infrastructure for research data from medicine and health sciences, the humanities and the social sciences that is focused on collection, quality-assurance, documentation (metadata), capacity building and services to improve accessibility. The activities are conducted at the University of Gothenburg. SND is the Swedish service provider in CESSDA (Consortium of European Social Science Data Archives), a collection of European social sciences data archives and a distributed infrastructure for social sciences data.

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The Swedish National Study on Ageing and Care in Kungsholmen, SNAC-K[13]

The aim of SNAC-K is to conduct a geographically constrained and individual-based data collection over a long period of time (30 years or more) that describes ageing, health and the incidence of healthcare needs from a social, medical and psychological perspective. It also registers what measures the individual receives from the municipal elderly care service and the county health services. Data highlighting what measures are implemented by family members and voluntary organisations are also gathered. The information is added to an infrastructure consisting of longitudinal data. The aim of the infrastructure is to facilitate the monitoring of individuals and the care measures implemented in the area over time in order to study how the need for health and social care develop, how well they are met and what results are obtained from the measures in a holistic sense.

VEGA/Nordsim

The new VEGA centre, which started in 2014 at the Swedish Museum of Natural History, uses laser technology to detach material from geological samples that can then be analysed with the help of a mass spectrometer. Such technology is essential to a wide range of current research topics in the geosciences, permitting both fundamental and innovative investigation of the chemical and isotopic composition, atomic structure (surface and internal) and surface texture of both natural (minerals, fossils, etc.) and synthetic materials. The Nordic instrument Nordsim is similar, but the material is instead detached using an ionic beam.

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4 SUPPLEMENTARY GRANT

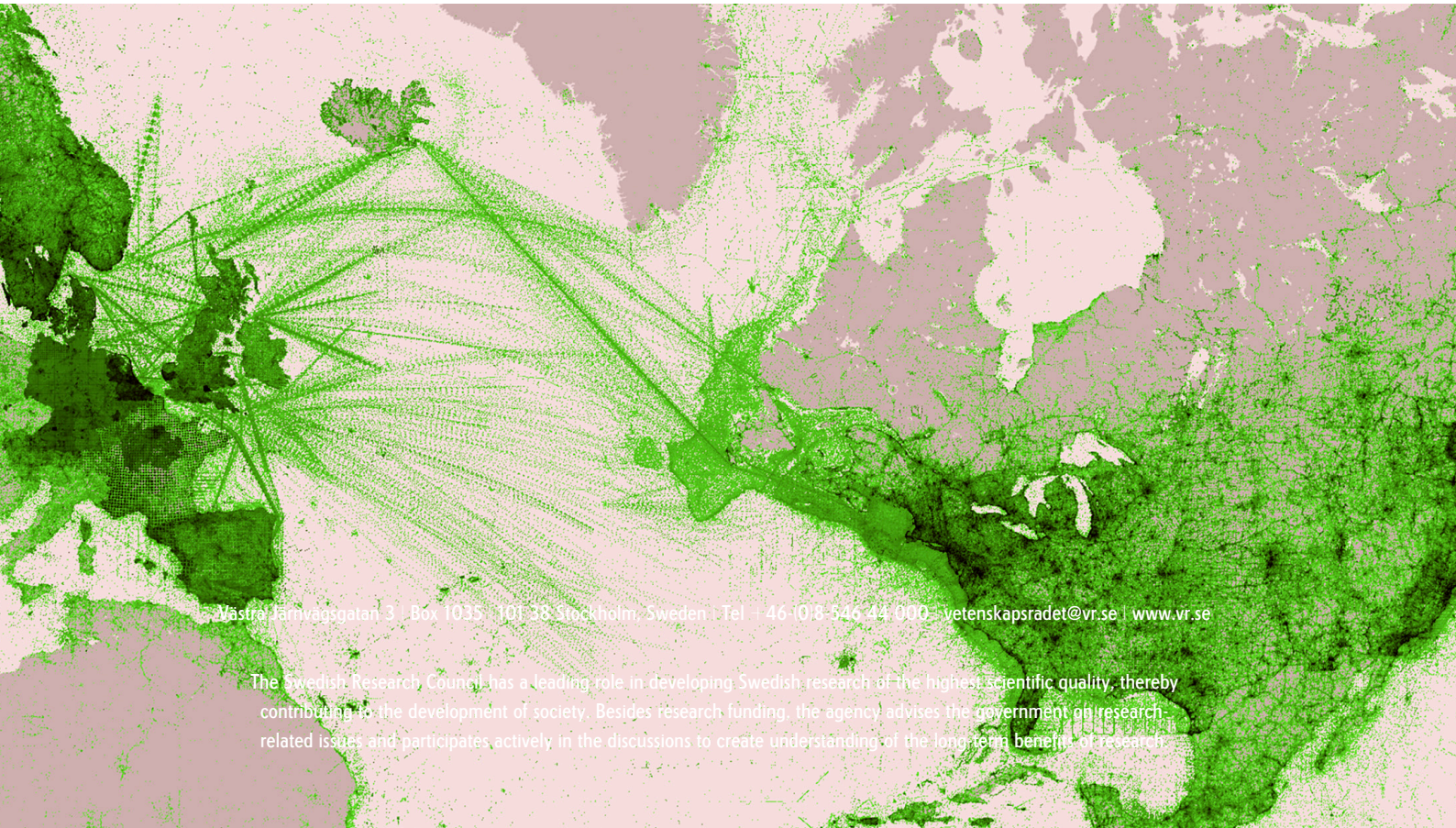
Apart from for the infrastructures listed above, grants can also be applied for to fund increased Swedish involvement in international infrastructures in which Sweden already is a formal member. Supplementary grant should cover costs for clearly defined Swedish scientific activities such as calls for in-kind contributions or similar, where Swedish scientists intend to contribute and require additional funding to do so.

An updated list of all research infrastructures funded by the Swedish Research Council can be found at www.vr.se.

The prioritisation of infrastructures at a national level is done by the Swedish Research Council through a four year cyclic process that starts with the publication of a guide for infrastructure, The Swedish Research Council's Guide to Infrastructures.

The guide is updated every second year of which every second time only in the form of an appendix. The preparations of the guide is done through an open inventory based on input from Swedish higher education institutions and other relevant actors which were invited to hand in suggestions on needs for new or upgraded infrastructure.

During 2015 the first inventory of needs were conducted. The infrastructures and areas that were assessed of highest priority are included in this appendix, to the guide 2014. It is only infrastructures included in this appendix that can apply for grants in the call of 2017.



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The Swedish Research Council has a leading role in developing Swedish research of the highest scientific quality, thereby contributing to the development of society. Besides research funding, the agency advises the government on research-related issues and participates actively in the discussions to create understanding of the long-term benefit of research.