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EIROforum Position Paper

European Research Infrastructures: Value, Role and Support in Horizon Europe

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EIROforum is an organisation of eight European Research Infrastructures
CERN, EMBL, ESA, ESO, ESRF, EUROfusion, EuropeanXFEL, ILL.
For this document, ESA has abstained from being a signatory.

Executive Summary

The European Council conclusions from 29 May 2018 state that research infrastructures (RIs) "*play an essential role in the advancement and circulation of knowledge, the fostering of scientific excellence and enabling researchers to participate in cross-border research activities*". EIROforum fully endorses this statement and emphasises that RIs are cornerstones of their respective scientific communities. RIs are pivotal in sustaining and enhancing the competitiveness and world-class excellence of the European science.

In order to support technology development and upgrades of European RIs, to unlock their innovation potential, and to allow Europe to remain a global leader in many scientific and technological domains, the Research Infrastructure programme in Horizon Europe should be supported well beyond the proposed budget of € 2.4 billion, which is insufficient to meet Europe's ambitions as expressed in the Council conclusions.

Framework programme funding is well suited for the development of a wide range of scientific, technical and industrial activities conducted in a coordinated way by European RIs. As demonstrated by previous framework programmes, the following activities—supported by a future RI programme in Horizon Europe—are central to achieving a unified research area open to the world in which scientific knowledge, technology and researchers circulate freely:

- Design studies and preparatory phase of ESFRI[2] and other world-class infrastructures
- Joint development of scientific instrumentation for RIs
- Collaborative networks and clusters of RIs, integration and federation of their scientific communities
- Transnational access to RIs
- Promoting collaboration with industry, technology transfer and innovation activities at RIs, including applications beyond the scientific domain of the RIs, as well as encouraging RIs to be a supplier for industry
- Training the next generation of scientists, engineers, technicians, and managers of RIs, and promoting exchanges of experts between RIs
- Developing methodologies to assess the value and the socio-economic impact of RIs

Those pan-European activities as a whole cannot be supported and carried out efficiently at the national level alone, and are not funded by other EU programmes. In order to maximise the potential of European RIs and build on the successes enabled by previous framework programme funding, EIROforum

[2]European Strategy Forum on Research Infrastructures

calls for strong support for the development, upgrade, community-building, and access activities for European RIs in Horizon Europe.

This position paper outlines EIROforum's view on the importance of robust support in Horizon Europe of the RI programme to benefit RIs across all scientific domains and enable them to fulfil their critical role in European science, technology, industry and society. The examples listed in the annex are offered as key success stories of how the Framework Programme for Research and Innovation can create European added value.

Research infrastructures in Horizon Europe

European RIs have an essential role in driving and sustaining the world-class excellence of European research. They will play a pivotal role in the Open Science pillar of Horizon Europe, as excellent training grounds for young scientists and engineers under the Marie Sklodowska-Curie actions, and as centres for fundamental breakthroughs achieved by awardees of European Research Council grants. In the Open Innovation pillar, RIs will be active as drivers of technologies with novel applications under the pathfinder projects of the European Innovation Council. RIs are primed to contribute to other core programmes, oriented towards addressing global challenges through the strategic research missions or as advanced partners in collaborative projects of the main clusters of the Global Challenges and Industrial Competiveness Pillar. European RIs are well positioned to engage in interdisciplinary, cross-sectoral, cross-policy, cross-border and international cooperation research in relevant clusters.

Without strengthened support in Horizon Europe for the continued integration of European scientific communities and for the RIs, the pan-European development of the next generation of scientific instrumentation and facility upgrades will be undermined. This can result in a negative impact on the important role RIs play in advancing both the open science and the open innovation agendas. As an example, it could have an adverse effect on the expansion of recently launched[3] promising collaborations with industry and innovation activities to generate applications beyond the scientific domain of the RIs. Simultaneously, while RIs in Europe frequently act as hubs for Marie Sklodowska-Curie actions, and continue to nurture and attract European Research Council grant holders, neither of these schemes can replace the specific activities of the RI-programme.

Comprehensive support for the early stages of pan-European RIs from design and preparatory-phase study funding is essential, but it must be complemented by supporting and consolidating existing RIs. This is particularly important when it comes to transnational access, collaborative networks, landscaping, road mapping, joint development of scientific instrumentation and facility upgrades, collaboration with industry, technology transfer, and innovation activities towards societal and industrial applications.

[3] ATTRACT: https://attract-eu.com/

Supporting European resources in cloud computing, data curation and mining, annotation, standardization and analysis is crucial to reap the benefits of the data revolution in various scientific fields. Likewise, measures to integrate innovation from commercial cloud providers in the European Open Science Cloud (EOSC) is vital, as highlighted by the work in Helix Nebula[4]. In this regard, the EOSC has much potential and should receive continued support in Horizon Europe.

EIROforum stresses that the Research Infrastructures programme remains unique, with distinct European added value that has no equivalent at national level and is not provided by other EU programmes. The participation of RIs in the other parts and pillars of Horizon Europe will not substitute by any means the support that European RIs receive through the RI programme.

Research infrastructures: Cornerstones of European scientific excellence

RIs develop and provide state-of-the-art instruments for carrying out fundamental science: a quest for new knowledge from examining the ingredients of life and matter, to unravelling the history the universe, contributing to many Nobel Prize winning discoveries[5]. The scientific enterprise of their design, construction and operation marshals and sustains international collaborations of scientists, engineers, technicians and administrators for the inherently peaceful purpose of advancing the frontiers of knowledge. European RIs strengthen and support their respective scientific communities, continually raising the bar of scientific discoveries and creating competitive forces that drive excellence in science. World-leading facilities, such as those offered by the EIROs and European RIs have become essential in structuring and integrating large scientific communities and fostering collaboration across Europe. This community consolidation further enables scientists to conceptualize and provide input into the requirements and design for RIs and concepts for future facilities. Moreover, it has resulted in collaborations around ambitious scientific projects that are key to driving scientific excellence in Europe.

Community integration requires researcher mobility and broad access to facilities, and the EU Framework Programmes for Research and Innovation have greatly enhanced the participation in cross-border research and innovation activities. These programmes have enabled vast groups of researchers across Europe, including the EU13 countries, to access state-of-the-art research infrastructure according to scientific merit. Transnational access and mobility schemes under FP7 and Horizon 2020 have proven very useful tools in this regard, for both emerging as well as already well-established

[4] Helix Nebula: http://www.helix-nebula.eu/

[5] E.g. the contribution of ESRF to the 2009 Nobel Prize in Chemistry, the contribution of ESO to the 2011 Nobel Prize in Physics, the contribution of CERN to the 2013 Nobel Prize in Physics, the contribution of the ILL to the 2016 Nobel Prize in Physics, and the contribution of EMBL to the 2017 Nobel Prize in Chemistry.

scientific communities. Evaluations of the RI programme under FP7 and Horizon 2020 have proven very useful tools in this regard, for both emerging as well as already well-established scientific communities. Evaluations of the RI programme under FP7[6] and H2020[7] confirm it addressed and continues to address many of the policy needs of all member states of the EU. All these important aspects of the RI programme benefit greatly the European scientific community and should receive appropriate support in Horizon Europe.

Strong support for European Research Infrastructures is essential as they:

- **Harness scientific expertise that drives discoveries and knowledge creation;**
- **Offer access to researchers from Europe and beyond to the best and in some cases, unique state-of-the art, facilities based on excellence alone;**
- **Enable integration of research communities from all countries in Europe,**
- **Maintain the world-class excellence of European science**

Value of Research Infrastructures for European industry

The collaboration between RIs and European industry is driven by the requirements for cutting-edge instrumentation as well as for access to highly advanced techniques, facilities, data and expertise. Industry acts both as a supplier—often jointly developing hi-tech components with the facilities—and, in certain cases as a user, where RIs provide unique capabilities for industrial research and development, such as in testing and development of new components and materials.

RIs have a need for state-of-the-art instrumentation encompassing a multitude of fields including, for example, novel detector and imaging technologies, advanced data acquisition systems, high performance and high capacity computing and communication networks. The resulting technologies of such collaborations often have spill-over applications in other domains and industrial sectors that cover a whole spectrum ranging from cancer treatment and new medicines, to the aerospace and automotive industries.

The precision, sensitivity, tolerance and other technical requirements for RI instruments often far exceed the requirements of conventional industrial uses; thus RIs are key capability drivers for industry. As a result, the continuous cycle of technology developments in RIs feeds a cycle of innovation not only in their respective areas, but well beyond. The Research Infrastructure Programme in H2020 also tackled this dimension with the aim of closing the trust gap between academia and industry in Europe. Various programs such

[6] Evaluation of Pertinence and Impact of Research Infrastructure Activity in FP7

[7] Interim Evaluation of the European Research Infrastructures including e-Infrastructures in Horizon 2020

as ATTRACT and the EOSC were launched and create links to industry.

The development of novel instrumentation and cutting-edge technologies at European RIs is often done in close collaboration with industry, and leads to both incremental and breakthrough innovation. Knowledge and technology transfer via joint collaborative R&D, via services, procurement and spin-off companies is of significant benefit for European industry. RIs now become key drivers for the continuous cycle of technology developments that can feed the cycle of innovation beyond their respective scientific areas.

Value of Research Infrastructures for European Society and Economy

Human progress is achieved through new discoveries and their implementation. In current times, scientific breakthroughs are typically realised with the support of a first-class RIs. Scientific developments made in RIs drive knowledge creation and foster the likelihood of technological breakthroughs with vast societal and industrial applications. The RI missions and science fascinate the general public, from school-children to grandparents[8], and inspire young people to pursue careers in science, technology and engineering. As hubs of excellence for their respective scientific communities, RIs provide invaluable training opportunities for young researchers, engineers and technicians, who continue their careers in other academic institutions or in European industry.

Many world-changing technologies and applications that we take granted today such as satellite and wireless communications, mobile phones, MRI scanners and cancer treatments are the result of developments and breakthroughs in fundamental research, such as electromagnetism, Einstein's theories of relativity, or the sequencing of the human genome. The results of such fundamental breakthroughs, sometimes unexpected and often without concrete application in mind, inevitably find their way into everyday life[9].

Studies and activities to demonstrate and evaluate the socioeconomic importance of RIs have added value, but require additional funding and support

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[8]CERN hosts annually around 140,000 visitors of all ages coming from 80 countries around the globe. ESO's education and outreach centre, Supernova, has hosted 57,000 visitors including 5,000 school children in the first ten months of its operations, which began in April 2018.

[9]IOne of the earliest descriptions of the eventual major impacts of fundamental research was captured in 1939 in the classic essay, The usefulness of useless Knowledge, by A. Flexner. More recently, for example, by conducting an extensive study of drug development, Harvard scientists made the startling conclusion "most transformative medicines exist because of fundamental discoveries that were made without regard to practical outcome and with their relevance to therapeutics only appearing decades later." Spector, J et al. "Fundamental science behind today's important medicines." Science translational medicine 10.438 (2018). http://stm.sciencemag.org/content/10/438/eaaq1787

of experts. Based on the Commission staff working document[10], released in 2017, the RI program in Horizon 2020 has issued calls to address the topic and more will be needed in Horizon Europe.

RIs have evolved and developed synergies with neighbouring scientific fields. Their technologies often find applications well beyond their initial scientific domain and the use for which they were originally intended. In order to keep evolving and to be able to address the societal challenges of the time, RIs needs both cutting-edge technologies and a solid community of curiosity driven scientists. Their future will depend on continuous development, of innovative technologies as well as accessing a pool of well-educated, well-trained scientists and engineers.

Research Infrastructures provide numerous benefits to European society and economy, either directly, through addressing societal challenges or industrial needs, or indirectly through training and education, as well as knowledge and technology transfer activities.

CONCLUSION

In order to support the world-class excellence of European science, to enable European RIs to stay at the forefront of their science and technology fields, and to provide direct and indirect benefits for European industry, society and economy, the RI programme in Horizon Europe should be funded at an adequate level, with a budget increase with respect to H2020 commensurate with the overall budget envelope of the new programme.

ANNEX

European RIs as partners in addressing global challenges

The following examples, addressing two global challenges[11] in societal needs and biosphere, show the role of the RIs.

- **Fight against cancer:** Cancer is a major societal issue worldwide and especially in Europe, where close to 4 million new cases per year are diagnosed and related healthcare costs per annum exceed € 100 billion[12]. Next-generation cancer detection and treatment will rely on technological breakthroughs in a variety of areas: cross-country genomics studies, pharmaceutical target validations, advanced radiation and hadron therapy, as well as advances in imaging and detector technology. European RIs will continue to play a major role in all of the above as well as in the development and testing of novel drug treatments, such as immunotherapy and cancer vaccines, and contribute to the progress in ion beam therapy and in-vivo imaging technologies.

- **Reversing ocean biodiversity loss:** The ocean ecosystem is critical to life on Earth and ocean biodiversity continues to decline in every region of the world. Analysing and tackling this requires coordination across sectors and policy domains. Combating ocean biodiversity degradation is an interdisciplinary scientific challenge, requiring the integration of research and data from the level of (bio)molecules to cells to organisms to ecosystems to biospheres. This will require the utilisation of state-of-the-art RIs, the development of enabling technologies and the integration of various data sources.

The added value of the Research Infrastructure program: European scientific and technological excellence

Combating antimicrobial resistance (AMR)

The state-of-the-art instrumentation and computing capacity of EMBL, together with funding from the European Research Council (ERC) played a vital role in three recent discoveries[13] that will help humanity in our efforts against antimicrobial resistance (AMR). One of the major global threats identified by the World Health Organization[14], the spread of antimicrobial resistance, could inverse many of the medical breakthroughs of the last century if previously

[11] https://ec.europa.eu/info/sites/info/files/transitions-on-the-horizon-2018_en.pdf
[12] R. Luengo-Fernandez, et al Lancet Oncol, 14 (2013), pp. 1165-1174
[13] L. Maier, M. Pruteanu, M. Kuhn et al. "Extensive impact of non-antibiotic drugs on human gut bacteria". Nature, published online 19 March 2018. DOI: 10.1038/nature25979; A. Brochado et al. "Species-specific activity of antibacterial drug combinations". Nature, published online 4 July 2018. DOI: 10.1038/s41586-018-0278-9; A. Rubio-Cosials et al. "Transposase – DNA complex structures reveal mechanisms for conjugative transposition of antibiotic resistance". Cell, published online 15 March, 2018. DOI: 10.1016/j.cell.2018.02.032
[14] WHO: Antimicrobial resistance: global report on surveillance 2014

curable infectious diseases become untreatable. The scientists that unravelled the molecular basis of a major antibiotic resistance transfer mechanism, developed the first proof-of-principle for blocking this transfer and carried out the first-of-a-kind large-scale screening of 3000 drug combinations on three different disease-causing bacteria of its kind.

Digital evolution – Open science

Industry is increasingly utilising the data and software by RI's to create new products, services and business opportunities. A good example of this is the Open Targets public-private partnership[15], is which has brought together some of the world's leading pharmaceutical and biotechnological companies in utilizing the world's most comprehensive range of freely available molecular databases and resources of EMBL-EBI. Combining the latest large-scale genetics, genomics data and computational analysis, the companies carry out pre-competitive collaboration with the aim of improving the success rate for developing new medicines.

Collaborative cross-community projects funded by the RI programmes developed data policies and continue to promote data and publication DOIs, together paving the way for "open science" to become reality. With regard to the open science agenda, open but with fair reciprocity, the Horizon Europe proposal puts forth important contributions by suggesting mandatory policies for depositing outputs in repositories and databases, as well as by accepting project expenses for example, making data "Findable, Accessible, Interoperable, and Re-usable" (FAIR). This is a step in the right direction, but it will be crucial for Europe in order to maintain a competitive advantage in: cloud computing, data curation and mining, annotation, standardization and analysis to be able to reap the benefits of the data revolution in science. In this regard, the EOSC has much potential and should be developed rapidly.

CompactLight design study

The key objective of the *CompactLight H2020 Design Study* is to create an affordable multi-purpose research infrastructures in Europe based on innovative technologies, here an X-ray free electron laser (XFEL). The overall concept underlying this project is to bring together recent advances in many of the important technical systems that make up an XFEL machine to produce the design of a next-generation facility with significantly lower cost and size than existing facilities. The goal is to make XFELs feasible for smaller countries, regions and universities.

Proof of concept of AIDA-2020

SMART (Silicon-based Microdosimetry System for Advanced Radiation Therapy) is a proof-of-concept project, funded under the H2020 Integrating Activity AIDA-2020, implemented by the Instituto de Microelectrónica de

[15] https://www.opentargets.org/

Barcelona. Based on the transfer of technologies developed in RIs to medical applications, SMART aims to develop a real-time system that will measure the dosage of radiation delivered to tissue during radiation therapy with hadron particles. As this technique is growing in popularity for cancer treatment, it is crucial to optimise the delivery of radiation effective treatment, while minimising the damage to healthy tissues in the patients.

Integrating and opening research infrastructure of European interest (NMI3, SINE2020, CALIPSO, etc)

Beginning with the Large Installation Program (LIP) under the second framework program (1987-1991) as a pilot project for the neutron facilities to establish "Europe-wide access to large scale facilities," the neutron as well as the photon community have since been supported and continuously grown together, up to creating the League of European Accelerator-based Photon Sources (LEAPS[16]) and the League of advanced European Neutron Sources (LENS[17]). Such an organized network of analytical facilities is essential to the coherent development of open access and for creating synergies in various technological domains.

Value of Research Infrastructures for European industry

CERN spends on average annually circa 500 million Swiss francs on procurement contracts for goods and industrial services. Several studies show the impact of CERN's procurement activities on technology transfer and innovation[18]. The results of the study[19] on the technology-intensive procurement (worth ~ € 1 billion) for the LHC project indicate that many corollary benefits are associated with such a procurement activity. For example, as many as 38% of companies developed new products or services as a direct result of the supplier project; 13% started new R&D units; 14% started new business units; 17% opened a new market; 42% increased their international exposure; and 44% indicated significant technological learning. Other studies[20,21] reveal that the "utility ratio" (increased revenue + cost savings)/(procurement value) was in the range of 3:1, meaning that each CHF that was spent by CERN in procurement generated three CHF worth of additional value to the suppliers of high-tech equipment for the LHC.

[16]https://www.leaps-initiative.eu/

[17]https://www.ill.eu/news-press-events/news/general-news/founding-partners-sign-charter-establishing-neutron-source-consortium-lens/

[18]"Does CERN procurement result in innovation?" S. Åberg, A. Bengtson, 2015

[19]Technology Transfer and Technological Learning through CERN's Procurement Activity, E. Autio, M. Bianchi-Streit, A. Hemeri, 2003

[20]The economic impact of technological procurement for large-scale research infrastructures: Evidence from the Large Hadron Collider at CERN, P.Castelnovo, M. Florio, S. Forte, L. Rossi, E. Sirtori, 2018

[21]The Impacts of Large Research Infrastructures on Economic Innovation and on Society: Case Studies at CERN, OECD 2014

[22]External effects of Basic research Infrastructure, M. Neumann, 2014

The European Synchrotron Radiation Facility (ESRF) X-rays provide powerful opportunities for commercial R&D, enabling companies to develop new products, refine existing ones, and improve their manufacturing processes by allowing them to examine materials in manner that goes far beyond what is possible with standard laboratory-based techniques. These advanced analytical experiments have an impact on European industry across a multitude of domains, including drug discovery and development, battery research, catalysis, metallurgy, consumer products and medical devices, among many others. For example, studies on formulation carried out at ESRF by one company have opened up a new market worth €1.2 billion. In addition to direct commercial access, around 30% of public beam time used at ESRF has a direct link with industry. As a result of the knowledge transfer that takes place, such academic-industry collaborations can lead to the direct commercial use of the facility, providing a strong added value for industrial innovation.

A study of European XFEL during its early construction phase (2009-2017) on the external effects of RI shows the impact in technological and organizational learning as well as how companies involved in the construction gained reputation not only in Germany but also in other regions of the world.

The non-destructive determination of residual stresses in engineering components is limited to surface or near-surface regions and offers limited spatial resolution. Bulk stress mapping is generally performed using destructive methods, which not only limits the possibility for further investigations but also involves the destruction of expensive and highly elaborate parts. To give industry the investigation tools it needs to make advances in areas such as additive manufacturing, hardening processes and welding, ILL operates a "Stress Analyser for Large-Scaled engineering Applications" (SALSA). Using this neutron diffractometer, it is possible to perform truly non-destructive strain and stress measurements, in the form of profiles or maps, beneath several centimetres of metal or ceramic. Thanks to the non-destructive nature of SALSA, investigations can be carried out over full development cycles, since the same sample can be measured time and again, once it has undergone further treatment or ageing tests.

As a pioneering initiative funded by the H2020 RI programme, ATTRACT's goal is to exploit the innovation potential of research infrastructures and to strengthen the competitiveness of European industry. It will advance breakthrough innovation and will have a big impact on European economy and society as it brings together fundamental research and industrial communities to develop the next generation of detection and imaging technologies in Europe. For the first time, a consortium of big research organisations – which build and operate telescopes, particle accelerators and other capital-intensive scientific instruments – will be explicitly leveraged to capture value and create jobs and growth. For this, ATTRACT has enlisted leading representatives of international public and private organisations and will solicit large companies, experienced venture capitalists, and individual investors alike. The aim is to create an entirely new model of open innovation that can become an engine for jobs and prosperity for Europe. One hundred and seventy projects aiming to develop demonstrate and validate breakthrough technology concepts in the domain of detection and imaging technologies across Europe will be funded under the first open call of ATTRACT, which closed on 31 October 2018, with a lump-sum of €100 000 each. A total of 1211 proposals were received, of which 30% were submitted by European industry (start ups, SMEs, and large companies).

Research Infrastructures linked to European society and economy

Thousands of hospitals around the globe employ positron-emission Tomography (PET) as an aid to the diagnosis of diseases such as dementia and cancer. In modern PET-CT (computer-tomography) scanners, 3D imaging is often accomplished with the aid of a CT X-ray scan performed on the patient during the same session, in the same machine. PET technology has been advanced over 40 years thanks to the work carried out at CERN and other research laboratories around the world. The technologies and scientific advances behind high-energy physics – through developments in accelerators, detectors and computing – have had significant contributions to the field of medical imaging.

In 2017, there were approximately 37 million people living with HIV[23] and tens of millions of people have died of AIDS-related causes. HIV treatment includes medications to prevent and treat the many opportunistic infections that can occur when the immune system is compromised by HIV, as well as the use of antiretroviral therapy (ART) to attack the virus itself, with the aim of halting the development of AIDS. HIV-1 protease is an enzyme responsible for the maturation of virus particles into infectious HIV virions, which ultimately leads to the development of AIDS. Without effective HIV-1 protease activity, HIV virions remain non-infectious. Given its fundamental role in HIV replication, the disruption of HIV-1 protease activity is a key target for successful ART drugs. At ILL, scientists have used neutron crystallography to determine the structures of HIV-1 protease/drug complexes, providing vital information to help design new, more effective ART drugs.

Every year, 290 000 to 650 000 deaths and 3 to 5 million cases of severe illness worldwide are associated with flu[24], an infectious disease caused by influenza viruses A and B. Vaccines and anti-viral drugs are available for flu, but viral strains with resistance to these drugs are emerging. The need for an effective drug with a novel mechanism of action is high. A promising target for these drugs is one of the flu virus's enzymes, influenza polymerase.

[23] https://www.hiv.gov/hiv-basics/overview/data-and-trends/global-statistics
[24] World Health Organization, https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal)

In 2018, scientists at the European Molecular Biology Laboratory (EMBL) succeeded in determining the molecular structure of this enzyme using X-ray diffraction data collected on beamlines at the European Synchrotron Radiation Facility (ESRF). Understanding the structure of influenza polymerase makes it easier to identify drug candidates that could stop it from working, halting the progress of the virus by preventing new viruses from being made. EMBL researchers are continuously working on influenza polymerase with the aim of supporting the development the next generation of influenza drugs.

In the domain of personalised medicine, we are starting to realise how the use of genomic sequence testing will revolutionise medical treatment and the implications of this for national healthcare systems. These discoveries, often carried out with the help of an RI, underpin many areas of the world's economy. The translation into economic wealth is staggering: the global pharmaceutical market is estimated to reach nearly € 70 billion in 2019[25], and the MRI market € 5 billion by the year 2020[26].

With the continuous depletion of natural resources and fossil fuels in particular, power consumption is one of the major global challenges that needs to be addressed today in order to secure the supply of energy for the future generations. Electricity production by means of fusion, the thermo-nuclear reaction that powers the Sun and the stars, will provide safe, non-carbon emitting and virtually limitless energy. ITER[27] is the largest magnetic fusion device, currently being constructed in Southern France, which will be used for research and demonstration of the feasibility of fusion as energy source with enormous potential impact for the future of mankind. Many of the novel technologies to be used at ITER to tame the hot plasma have been developed and tested at Joint European Torus (JET) currently exploited under EUROfusion; and the EUROfusion programme is focused on supporting the ITER construction and preparing ITER operation and scientific exploitation. ITER is also having a significant economic impact. It is delivering almost equal returns in increased gross value added (GVA) in the EU economy and has needed the employment of 34 000 job years in the period of 2008-2017[28] and is expected to deliver a gross extra GVA of €12.7 billion and 61 000 job years between 2018 and 2030[29].

[25]https://www.bccresearch.com/market-research/biotechnology/drug-discovery-technologies-report-bio020e.html
[26]http://www.axisimagingnews.com/2015/07/analysis-global-mri-market-reach-5-8-billion-year-2020/
[27]https://www.iter.org/proj/inafewlines
[28]http://trinomics.eu/project/iter-impacts/
[29]Brussels, 7.6.2018 SWD(2018) 325 final.