Position paper for the endorsement of Free Software and Open Standards in Horizon 2020 and all publicly-funded research

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Abstract

The Free Software Foundation Europe (FSFE) is a charity that empowers users to control technology by advocating for Free Software. In a digital world, Free Software is the fundament of Open Knowledge, Open Innovation and Open Science.

Software is an integral part of today's society. Our daily interactions, transactions, education, communication channels, work and life environments rely heavily on software. "Free Software" refers to all programs distributed under terms and licences that allow users to run the software for any purpose, to study how the program works, to adapt the program to their needs, to improve the program and to distribute the improved version of it so that the general public can benefit. Source code is a precondition for a user to study how the program works. The Free Software ideals of transparency, openness and collaboration are very much the same as the principles endorsed in scientific community, theory and process, and will support scientific and technological innovation in Europe and worldwide.

This paper summarises the FSFE's key recommendations on the midterm evaluation of the Horizon 2020 and the European Commission' s efforts to draft the Framework Programme 2018-2020. Implementing these recommendations will unlock the full potential of Open Science and Open Access investments, which are at the core of Horizon 2020.

In line with the European Parliament resolution of 19 January 2016 "Towards a Digital Single Market Act" (2015/2147(INI)) and common practices in major research institutions such as MIT, CERN and others, the FSFE makes the following recommendations:

1. **Open Standards should be preferred for all knowledge exchange, and in particular for the dissemination of scientific publications and the archival of all articles, data, and software used in scientific research. The use of Open Standards in data and software repositories and Data Management Plans (DMPs) concerning the Horizon 2020 publications, is necessary to ensure data preservation and Open Science. Research Funding Organisations should take the lead and foster changes of business models when dealing with research data.**
2. **Software developed with public funding, and in particular in the framework of the Horizon2020 programme should be mandatorily published under a Free Software licence.**
3. **Software developed with public funding, and in particular in the framework of the Horizon2020 programme should be mandatorily archived in**

a public software repository ensuring long term availability and persistent identification.

4. **Data and software repositories and Data Management Plans (DMPs) must employ Free Software in order to ensure unfettered access to their contents and long term preservation.**
5. **An "Open Science" Prize should be established to raise awareness and promote Open Science.**

Introduction

A Free Software project is like a scientific process

Free Software ideals are very similar to those which are fundamental to the scientific method. Both, Free Software and scientific theory, are based on transparency, openness and collaboration.

One of the pillars of the scientific method, is the ability to formulate a scientific theory and then test and improve it by independently reproducing and verifying it via scientific experiments.

Another essential pillar is the openness of scientific results to the whole scientific community to allow further research or validation. A scientific theory receives acceptance when the data and the method that has been used to work out the theory are available in full.

A scientific theory gains validation by its openness of data and methods which allow additional evidence to be gathered. It is an inherent part for a scientific theory to be rejected, approved or modified. Over time, as successive modifications build on top of each other, theories consistently improve and greater predictive accuracy is achieved. Different theories complement each other and create an environment of science and knowledge that is open to humanity to use, study, share and improve.

In a similar way, Free Software embodies the spirit of openness of data and methods (source code), verification and collaboration. As software is written code, it can be shared and improved like any other written knowledge or information. Free Software in this respect refers to all programs distributed under terms and licences that allow everyone to run the software for any purpose, to study how the program works, to adapt the program to their needs and improve it, while being able to distribute the improved version of the program so the general public can benefit from it. [1]

[1] Free Software, also known as 'open source', See more: Free Software Foundation, What is Free Software. Accessed 23/11/2016.

Using and furthering Free Software means that the code is open to be used and improved by private companies, organisations, public institutions and the general public. Improvements of the software are available for the public, so the whole society benefits. And just like in the world of science, different pieces of Free Software complement each other and create an environment of software and knowledge that is open to humanity.

Open Science, one of the main principles promoted by Horizon 2020, acknowledges how important it is for the future of Europe to have large-scale interactions in the research community, as this will speed up discovery and innovation. As OECD puts it in its latest Outlook report, Open Science is the next frontier.[2]

Nowadays, software is an integral part of nearly all modern research from data aggregation to the application of methods and the calculation of final results. Talking about "Open Science" means in this respect the openness of the software, the data and the file formats that are in use. Only the openness of the digital environment will allow modern research to further share the data and methods in use of their research and to keep open the environment of science and knowledge. This openness is in need of the use and development of Free Software.

In addition, the European Commission (EC) believes that as change accelerate and instability becomes the new norm, public engagement with science becomes key for Europe[3]. As we have seen, the freedom of the software to be used allows the general public and private companies to participate in the improvement of the sources. This means that the use of Free Software and Open Standards allows a boost in scientific tools and new modes of private engagement like citizen science.

Significance of software nowadays

Software is a vital part of today's society. Our daily lives, communication, interaction and the way we distribute and share information and knowledge is unimaginable without software. The digital revolution has meant almost every process or product relies on software, revealing the latter's big economic value. Just as scientific research has included the use of digital technology, software has become an integral part of modern research across all disciplines [4].

Conducting reliable research requires the scientific method to be transparent in order to be able to reproduce under the same circumstances. When Free Software is not used in scientific research, the possibility to do so is limited as the researcher

[2]OECD (2016), OECD Science, Technology and Innovation Outlook 2016, OECD Publishing Paris.

[3]European Commission, Directorate-General for Research and Innovation, Strategic Foresight: Towards the 3rd Strategic Programme of Horizon 2020, Brussels 2016, p 43. Accessed 23/11/2016.

[4]American Scientist, How Do Scientists Really Use Computers?. Accessed 23/11/2016.

lacks full access to the software used. This makes it impossible for the rest of the research community to access essential parts of the method that was used for the findings.

For accessibility, reproduction and transparency in scientific research, the use of Free Software is inevitable. Some authors identify the movement towards a Free Software development of technology as part of the megatrends that will drive innovation and change the face of the world the next years.[5]

Why is Free Software important for scientific research?

The FSFE believes that in order to be valid, research has to be conducted using Free Software, as it is the only way to ensure fully transparent access to its methodology. To choose a software that is not published under a Free Software licence [6], is a choice against transparency.

To illustrate the importance, we can look into the recent Volkswagen emissions scandal. A scandal that revealed Volkswagen had intentionally programmed diesel engines to cheat during laboratory emissions testing. As a result of these software manipulations, it was later known that the Volkswagen engines emitted nitrogen oxide pollutants up to 40 times above what is allowed in the US,[7] while test results showed the cars to meet allowed US standards. The software was revealed by a group of private researchers after years of independent research.

The Volkswagen case shows how important the reliability of software is for scientific metrics, method applications and calculation of results. Other software leaves researchers in uncertainty and in the uncomfortable position to take results as granted instead of having the possibility to testify and verify them. Free Software instead, as argued above, offers transparency and verification of the whole research process.

However, the benefits of Free Software go way beyond the matter of transparency and accessibility. Free Software also offers the only way for scientific research to be sustainable and accessible in the long run. Free Software offers no legal costs and less legal uncertainty when it comes to the reuse and distribution of software used in research projects, making it perfect for transnational scientific collaboration, which is on the rise.[8] The use of Free Software in publicly funded research would boost cooperation inside the European science community and reduce research cost. Free Software is reusable multiple times and not subject to the restrictions and barriers imposed by other software.

[5]OECD (2016), OECD Science, Technology and Innovation Outlook 2016, OECD Publishing, Paris.
[6]Free Software licence as approved by the Free Software Foundation and Open Source Initiative.
[7]Hotten, R. (10 December 2015) Volkswagen: The scandal explained, British Broadcasting Corporation. Accessed 23/11/2016.
[8]OECD, OECD Science, Technology and Innovation Outlook 2016, OECD Publishing, Paris.

As the scientific research community relies more and more on digital data repositories to manage and disseminate scientific data, it is crucial the underlying systems that run these repositories are based on Free Software and offer their content in Open Standards.[9]

Digital preservation requires an ability for information stored or encoded in one technology to be migrated to another data format, operating system or hardware. It is inevitable and unavoidable. For this purpose, only repositories that are based on Free Software and Open Standards can guarantee long-term preservation and universal access to the data, as they allow the biggest interoperability between different technologies.

In contrast, software repositories based on closed incompatible standards may produce technological incompatibilities, limitation of the universal access and possibly higher costs of maintenance and future migration processes.

Recommendations

Data preservation and Open Science through Open Standards

- **Open Standards should be preferred for all knowledge exchange, and in particular for the dissemination of scientific publications and the archival of all articles, data, and software used in scientific research. The use of Open Standards in data and software repositories and Data Management Plans (DMPs) concerning the Horizon 2020 publications, is necessary to ensure data preservation and Open Science. Research Funding Organisations should take the lead and foster changes of business models when dealing with research data.**

Open Standards are the foundation of cooperation in modern society.[10] They allow people to share data freely, prevent vendor lock-in and other artificial barriers to interoperability, and promote choice among vendors and technology solutions.[11]

The best example of the significant value of interoperability and Open Standards is the World Wide Web. If the World Wide Web was stripped of its interoperability features, the Web as we know it today would never have existed. The Internet itself grew

[9] Free Software Foundation Europe (FSFE), Open Standards. Accessed 23/11/2016.
[10] Ibid.
[11] Wikibooks, FOSS Open Standards/Importance and Benefits of Open Standards, September 2014. Accessed 20/11/2016.

mainly thanks to widely shared protocols and standards[12], that are easily accessible to everyone.

Regarding Open Knowledge and Open Science, the whole research process should be structured upon comprehensive policies that encompass measures related to the reuse and re-distribution of scientific data, ensuring universal participation and cooperation. These measures must be taken into account at all levels of a scientific process when designing, creating, disseminating and evaluating data, information and knowledge.[13]

The FSFE therefore suggests the full endorsement of Open Standards, defined hereinafter, as a necessary condition to ensure data preservation and Open Science. An Open Standard [14] refers to a format or protocol that is:

- subject to full public assessment and use without constraints in a manner equally available to all parties;
- without any components or extensions that have dependencies on formats or protocols that do not meet the definition of an Open Standard themselves;
- free from legal or technical clauses that limit its utilisation by any party or in any business model;
- managed and further developed independently of any single vendor in a process open to the equal participation of competitors and third parties;
- available in multiple complete implementations by competing vendors, or as a complete implementation equally available to all parties.

The FSFE suggests that this definition is included in the Guidelines on Open Access Policy and that Open Standards become mandatory for data repositories and DMPs concerning the Horizon 2020 publications.

Free Software as the default option for Horizon 2020

- **Software developed with public funding, and in particular in the framework of the Horizon2020 programme should be mandatorily published under a Free Software licence.**

[12]JPI Climate symposium, Report on "Designing Comprehensive Open Knowledge Policies to Face Climate Change", Vienna, October 2015. Accessed 20/11/2016.

[13]Aliprandi, S. (2011), Interoperability and open standards: the key to true openness and innovation, in: International Free and Open Source Software Law Review, 3(1), pp 5 – 24, DOI: 10.5033/ifosslr.v3i1.53 .

[14]Free Software Foundation Europe (FSFE), Open Standards definition, October 2016. Accessed 20/11/2016.

The FSFE calls for all software being developed in-house or by service partners paid with public money or public-private partnerships to be published under a Free Software licence. This way, the solutions developed by one research institution can be reused and distributed to other educational establishments and research institutions.

Several European research organisations and institutions are 'locked' into their ICT systems because knowledge about how the system works is available only to their specific vendor. This means every time they need to purchase new components or licences, only a single vendor can provide them. This severe lack of competition leads to higher prices and some € 1.1 billion per year is lost unnecessarily, in the public sector alone.[15] Reusable solutions, on the other hand, that are easily adaptable and customisable independently from a single vendor will help to reduce the possibility of ICT vendor lock-in in all fields heavily dependant on software solutions[16].

Releasing publicly funded software as Free Software also benefits society at large, as software can be reused, further developed and improved by everyone outside of the single public institution. Improvements can be done by single persons, other public institutions or even private companies. This way, everyone can benefit. In other words, the demand for publicly funded software to be published as Free Software underlines the need for "Science with and for Society", as described in the Work Programme 2018-2020.[17]

In this respect, the FSFE calls for full implementation of the European Parliament resolution of 19 January 2016 "Towards a Digital Single Market Act" (2015/2147(INI)) where the European Parliament urges the European Commission to increase the share of Free Software and its reuse in and between public administrations as a solution to increase interoperability.[18]. Additionally, the European Parliament demands that the EU 2020 strategy's research and innovation targets include […] "the increased use of free and open source software, particularly in educational establishments and public administrations, and easier access for SMEs and start-ups to Horizon 2020 funding adapted to the short innovation cycles of the ICT sector[emphasis added]."[19]

[15] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee of the Regions, Against lock-in: building open ICT systems by making better use of standards in public procurement, Brussels June 2013. Accessed 04/01/2017.

[16] Ibid.

[17] European Commission, Annex 1 - Background Paper to the Consultation on potential strategy and priorities for research and innovation in the Horizon 2020 "Science with and for Society" Work Programme 2018-2020, Brussels, March 2016. Accessed 24/11/2016.

[18] European Parliament, Resolution of 19 January 2016 on Towards a Digital Single Market Act (2015/2147(INI)), point 110. Accessed 22/11/2016.

[19] Ibid, point 125.

The FSFE supports the European Parliament's demands and asks the European Commission to take these demands duly into consideration when drafting the Work Programme 2018-2020.

Such a decision also goes in hand with prominent international public institutions that are using Free Software licences to release software that was funded and/or developed with public funds. In the USA, many public universities (e.g. MIT) and institutions (e.g. NASA) publish most of their software that does not contain any sensitive data, as Free Software. In Europe, the European Organization for Nuclear Research (CERN), an institution that is at the forefront of scientific and technological advancement, is basing its infrastructure on Free Software, and has a long tradition of Open Access.

Endorsing Free Software as part of Open Science

The Principle of Openness in Horizon2020

Horizon 2020 is the financial instrument implementing the Innovation Union which is the Europe 2020 flagship initiative aiming at securing Europe's global competitiveness. Its primary goal is to invest EU funds in scientific research for the common good.[20] Such common good can be scientific advances and technological inventions that ensure better living conditions, cure for incurable diseases, a growing employment environment and a sustainable future for the generations to come.

The produced knowledge should also be treated as a public good that will boost innovation and lead progress in Europe and beyond. As stated in the Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020, "the Europe 2020 strategy for a smart, sustainable and inclusive economy underlines the central role of knowledge and innovation in generating growth."[21]

According to Robert K. Merton, the results of scientific work are the results of cooperative efforts and must be made available to all scientists[22]. In the digital age, this approach is translated as demand for Open Access and Open Science based on Open Standards and Free Software, because the latter two contribute not only to scientific but also to social progress. New possibilities of sharing and access to information will boost

[20] European Commission, Communication from the Commission "Europe 2020 - A strategy for smart, sustainable and inclusive growth", Brussels, March 2010. Accessed 23/11/2016.

[21] European Commission, Directorate-General for Research and Innovation, H2020 Programme - Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020 v. 3.1., Brussels, August 2016. Accessed 23/11/2016.

[22] Merton, R. K., The Normative Structure of Science, in Merton, Robert K., The Sociology of Science: Theoretical and Empirical Investigations, University of Chicago Press, Chicago 1973.

knowledge management and enable new modes of civil participation like the so-called citizen science.[23].

So far, Open Access and Open Science try to grow from a theory to a reality.[24] However, for the time being the reality of access to scientific data is that only a very small number of publications are openly accessible,[25] despite the fact that more and more scientists choose Open Access models for the publication of results.[26]

Two recent European Commission public consultations showed that researchers, libraries, funders and businesses believe that the access to scientific information is problematic and this is a key barrier to the circulation of knowledge in Europe. Respondents to these consultations indicated Open Access as the key tool to overcome limitations. Over 90% of respondents believed publications resulting from publicly funded research should be available by open access.[27]

Open Access practices are well into play already in the anglo-saxon world. Specifically in the U.S., any work wholly financed by federal funds must be freely accessible to all,[28] while the so-called Public Access to Science Act, aims to extend this to any research work that receives major funding from public resources.[29] In the UK, all publicly funded work is being published under the Open Government Licence that grants access and reuse rights to everyone.

Thus, it is time for the European Union to take initiative. Scientific data and results paid with public money should be made available to the public.[30] In particular, publicly funded research must not disappear or lose its value due to payment barriers and private commercial interests.[31]

On the contrary, publicly funded research should become accessible to the public in efficient and sufficient ways. This will help the global scientific community and will strengthen the reputation of European science and European institutions within the EU.

[23]Fecker Benedikt, et al., Open Access oder: die Zurückeroberung der Autonomie, Alexander von Humbolt – Institut fuer Internet und Gesellschaft, HIIG Blog, November 2016. Accessed 23/11/2016.

[24]Organisation for Economic Co-Operation and Development (OECD), Making Open Science a Reality, OECD Science, Technology and Industry Policy Papers, No. 25, OECD Publishing, Paris 2015. Accessed 23/11/2016.

[25]European Commission, The 3 Os: Open Innovation, Open Science, Open to the World, Brussels 2016. Accessed 23/11/2016.

[26]OECD, OECD Science, Technology and Innovation Outlook 2016, OECD Publishing, Paris.

[27]European Commission, Background note on open access to publications and data in Horizon 2020, Brussels. Accessed 23/11/2016.

[28]Van Noorden, R., US science to be open to all, in: Nature 494, February 2013, pp. 414–415 Accessed 01/12/2016.

[29]Di Cosmo, R., Scientific Publications: The Role of Public Administrations in The ICT Era in: Free Software Licenses in Context, UPGRADE Vol. VII, No. 3, June 2006. Accessed 29/11/2016.

[30]OECD, OECD Science, Technology and Innovation Outlook 2016, OECD Publishing, Paris.

[31]Europan Commission, Online survey on scientific information in the digital age, European Union, 2012. Accessed 23/11/2016.

A good Open Access strategy will put the European Union in the forefront of a modern and digital science community.[32] Research institutions and universities all over the world call for Open Access and are engaged in collective initiatives for its promotion or have created their own Open Access policies.[33]

In addition, free public access to all publicly funded research is already described by the European Commission as "a vision of the future" of Open Science not only in Europe, but globally for the year 2030.[34]

Inclusion of software under Open Access

- **The software used or developed during scientific research, as integral part of scientific data should be covered by Open Access rules.**

The FSFE endorses the conclusions drawn by the Council of the European Union towards an Open Science system and acknowledges that unnecessary legal, organisational and financial barriers to access results of publicly funded research should be removed as much as possible.[35]

Based on the specific aspects presented in the first Annex of the Background Paper to the consultation on potential strategy and priorities for research and innovation in the Horizon 2020 "Science with and for Society" Work Programme 2018-2020[36], Free Software can be considered as deeply related to the most important aspects of it, such as public engagement, science education, ethics, open access and governance.

To specify, Free Software could be incorporated in many of the "Science With and For Society" Advisory Group' s suggestions and in particular concerning the following points: encouraging the youth to follow scientific and technological careers, promoting the so-called citizen science, and more importantly, developing the accessibility and (re-)use of the results of publicly-funded research.[37]

[32] OECD, OECD Science, Technology and Innovation Outlook 2016, OECD Publishing, Paris.

[33] Here are some examples: the DEAL project, the Budapest Open Access Initiative, the Max-Planck Institute.

[34] European Commission, Directorate-General for Research and Innovation, "Open innovation, open science, open to the world: A vision for Europe", 2016, page 34. Accessed at 02/12/2016.

[35] Council of the European Union, The transition towards an Open Science system - Council conclusions (adopted on 27/05/2016), 8791/16 RECH 133 TELECOM 74, Brussels May 2016. Accessed 23/11/2016.

[36] European Commission, Annex 1 - Background Paper to the Consultation on potential strategy and priorities for research and innovation in the Horizon 2020 "Science with and for Society" Work Programme 2018-2020, Brussels, March 2016. Accessed 24/11/2016.

[37] "Science With and For Society" Advisory Group, Strategic Opinion for research and innovation in the Horizon 2020 Work Programme 2018–2020 - Recommendations to the European Commission, Brussels May 2016. See p.19: points a), b) and e). Accessed 23/11/2016.

On the other side, in the EC Guidelines on Open Access, special attention is drawn upon the benefits of the broader access to scientific publications and data, including software and software tools/applications. The guidelines specifically encourage projects to provide information and access to specialised software or code in order to validate the results.[38]

Taking a closer look, it is obvious that benefits of Open Access do coincide with the four freedoms provided by Free Software licences: to use software, to study how it works, to share it with others, and to improve it according to one's needs. Thus, Open Access should not be merely understood as "free online access to publications", but instead to receive a more sophisticated definition, including the four specific freedoms.

In particular, the ability to build upon previous research results, which leads to improved quality of results, is a synonym to the freedom to improve the given software, based on previously developed code ["standing on the shoulder of giants"]. The encouragement of collaboration among the scientists and the avoidance of duplication or greater effort, coincides with the freedoms to use and to share software. Involving citizens and society, ensuring greater transparency of the scientific process is similar to the freedom to study how the software works. This means that there are no obstacles in logically extending EU Open Access policies to software. It is also noteworthy, that historically, Open Access movement has been closely related to Free Software that helped to shape the existing principles and ideas of Open Access as we know it today.[39] Consequently, there is no reason to deny the treatment of software on the equal level with scientific publications and data from scientific research as a part of broader Open Science movement.

In addition, the four freedoms granted by Free Software speed-up innovation, which in turn leads to faster market access and growth.[40] The Commissioner for Research, Science and Innovation Carlos Moedas has repeatedly emphasised on the importance of Open Innovation and Open Science for the overall growth of a society.[41]

[38] European Commission, Directorate-General for Research and Innovation, H2020 Programme - Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020 v. 3.1., Brussels, August 2016 Accessed 23/11/2016.

[39] Laakso, M., et al "The Development of Open Access Journal Publishing from 1993 to 2009", PLOS, 2011. Accessed 22/12/2016.

[40] "Science With and For Society" Advisory Group, Strategic Opinion for research and innovation in the Horizon 2020 Work Programme 2018–2020 - Recommendations to the European Commission, Brussels May 2016. Accessed 23/11/2016.

[41] Moedas, C., Commissioner for Research, Science and Innovation, Open Innovation, Open Science, Open to the World in : "A new start for Europe: Opening up to an ERA of Innovation" Conference, Brussels June 2015. Accessed 24/11/2016.

Therefore, in a future revision of the European Commission's policy on Open Access and more specifically, the Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020,[42] the FSFE suggests the inclusion of an annex for publishing software under FSF and OSI approved licences.[43] Moreover, we consider that Free Software and Open Standards should be explicit part of the Strategic Foresight,[44] the report which aims to support the preparation of the third strategic programme of Horizon 2020 (2018-2020), under the umbrella of Open Science.

It should be made clear that publishing software under Free Software licences does not mean that the researchers cannot have a financial profit out of their work[45]. It only means that their code carries the four freedoms.[46] If there are no specific ad hoc restrictions, there is no problem with the adoption of a Free Software licence over the project results. Free Software licensing might provide for better visibility, outreach and re-use of the results and could therefore be beneficial to the overall impact of the project in the scientific community.[47]

This is in accordance with the Open Access interpretation under Horizon 2020, as the online access to scientific publications, at no charge to the end-user.[48] Open Access therefore only aims at making the work of the researchers as widely accessible as possible – it does not aim at putting the publications in the public domain,[49] nor to allow the public to reproduce or redistribute a work without its owner's consent.[50]

Open Access as the default option for publications

- **Open Access is and should remain the default option for the scientific publications of Horizon 2020 projects. Opting-out should be an exception, strictly interpreted.**

[42] European Commission, Directorate-General for Research and Innovation, H2020 Programme - Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020 v. 3.1., Brussels, August 2016. Accessed 23/11/2016.

[43] Free Software licence as approved by the Free Software Foundation and Open Source Initiative.

[44] European Commission, Directorate-General for Research and Innovation, Strategic Foresight: Towards the 3rd Strategic Programme of Horizon 2020, Brussels 2016. Accessed 23/11/2016.

[45] European IPR Helpdesk, Fact Sheet: Open access to publications and data in Horizon 2020: Frequently Asked Questions (FAQ), Brussels May 2014. Accessed 22/11/2016.

[46] The four essential freedoms.

[47] European IPR Helpdesk, Will it be possible to release our Horizon 2020 project results (software) under an open source licence?. Accessed 22/11/2016.

[48] Suber, P., Open Access, The MIT Press Essential Knowledge Series 2012. Accessed 22/12/2016.

[49] European IPR Helpdesk, Will it be possible to release our Horizon 2020 project results (software) under an open source licence?. Accessed 22/11/2016.

[50] Open Access Scholarly Information Sourcebook (OASIS), Benefits of Open Access for research dissemination. Accessed 01/12/2016.

Open Access is the default option for scientific publications of Horizon 2020 projects, but there is still the possibility for the scientists to opt-out.[51]

The FSFE asks for full implementation of the extension of the Open Research Data Pilot[52] and in particular, "projects should provide information via the chosen public repository about the tools available to the beneficiaries that are needed to validate the results, e.g. specialised software or software code, algorithms and analysis protocols. Where possible, they should provide these instruments themselves." That being said, this information should include, not only code but also all the necessary documentation that ensures the reusability of software.

Opting-out should be interpreted strictly and be permitted exceptionally, in accordance with public interest.[53] It should also be valid only under very specific circumstances, as in accordance with the EC policy on Open Access [54] and the meeting of the Competitiveness Council in Brussels on 27 May, 2016. In this meeting, the EU ministers responsible for research and innovation decided unanimously that by 2020 all scientific publications on the results of publicly funded research in Europe must be freely available under Open Access.[55]

Maximum transparency during evaluation and interests balance

- **In the case of public funding of private organisations or public-private funding, the maximum transparency during the evaluation process of the projects should be guaranteed and an in-depth case-by-case assessment of interests balance should take place, always in favor of Open Access.**

Under the Horizon 2020 criteria, only legal entities and international European interest organisations are eligible for funding opportunities, excluding natural persons. That means not only universities or other state research organisations can get funded, but also private for-profit organisations.

[51] EU2016, All European scientific articles to be freely accessible by 2020 Europe makes a definitive choice for open access by 2020, Press release, May 2016. Accessed 25/11/2016.

[52] European Commission, Directorate-General for Research and Innovation, H2020 Programme - Guidelines on FAIR Data Management in Horizon 2020, Brussels July 2016.

[53] Council of the European Union, The transition towards an Open Science system - Council conclusions (adopted on 27/05/2016), 8791/16 RECH 133 TELECOM 74, Brussels May 2016. Accessed 23/11/2016.

[54] Europan Commission, Boosting the benefits of public investments in research, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, July 2012. Accessed 01/12/2016.

[55] EU2016, All European scientific articles to be freely accessible by 2020 Europe makes a definitive choice for open access by 2020, Press release, May 2016.

The FSFE calls for the maximum transparency during the evaluation processes of the projects and an in-depth case-by-case assessment of interests balance, in particular when private interests interfere with public interests. In other words, the FSFE welcomes and supports the Commission's position that it should not make a difference for Open Access application, whether the scientific publications on the results of research are supported by public or public-private funds.[56]

The Horizon 2020 research results (including software) must be freely accessible to everyone,[57] since it is required by the relevant EC documents that all the scientific publications of the results of publicly funded research (including private-public funds) are freely available and all the research data reusable. To achieve that, data must be made accessible, unless there are well-founded reasons establishing the opposite, for example, security or privacy issues.[58] The latter exceptions, however, need to be strictly interpreted and balanced out with other public objectives.

It is necessary to keep in mind that Open Access to publicly funded research data not only helps to maximise the research potential of new digital technologies and networks, but provides greater returns from the public investment in research.[59]

Repositories for Scientific Publications, Data and Software

- **Software developed with public funding, and in particular in the framework of the Horizon2020 programme should be mandatorily archived in a public software repository ensuring long term availability and persistent identification.**

The Free Software Foundation Europe encourages the archiving of the scientific knowledge, including software, in public repositories for further use both by researchers and civil society.

According to "Digital science in Horizon 2020", openness of research is defined as the only way to enhance the value of scientific knowledge by ensuring its accessibility for all, through online media.[60] This visibility also contributes to the quality, transparency and reproducibility of the research results. Nevertheless, this visibility can only be secured

[56] European Commission, Improving knowledge transfer between research institutions and industry across Europe, Brussels 2007. Accessed 23/11/2016.

[57] European Commission, Directorate-General for Research and Innovation, H2020 Programme - Guidelines on Open Access to Scientific Publications and Research Data in Horizon 2020 v. 3.1., Brussels, August 2016.

[58] European Commission, Digital science in Horizon 2020, Brussels March 2013. Accessed 23/11/2016.

[59] Organisation for Economic Co-Operation and Development (OECD), OECD Principles and Guidelines for Access to Research Data from Public Funding, Paris 2007. Accessed 22/11/2016.

[60] European Commission, Digital science in Horizon 2020, Brussels March 2013.

when open, immediate and free access to scientific results, including the software and models used for results generation, is ensured.

The FSFE welcomes the Open Research Data Pilot and other EC-initiated public repository initiatives such as the European Open Science Cloud (EOSC) and the JoinUp repository for code developed by and for public administrations across Europe.

Taking into account the First report and recommendations on the European Open Science Cloud, the FSFE would like to endorse the FAIR principles which will guide implementations to make research objects Findable, Accessible, Interoperable, Re-usable and ultimately citable. [61] The FSFE would like to emphasise that the FAIR terms are fully compliant with Free Software.

- **Data and software repositories and Data Management Plans (DMPs) must employ Free Software in order to ensure unfettered access to their contents and long term preservation.**

The FSFE insists that not only the scientific data on these platforms shall be open, but also the software these platforms run with should be made publicly available as Free Software, guaranteeing the preservation of digital knowledge over the years.

OpenAIRE is a great example of a Free Software archiving platform which is interoperable and reusable. With almost 17.5 m publications from the EU and in cooperation with the biggest South American repository La Referencia, it has become the largest inter-regional network for the hosting and distribution of Open Access publications in the world.[62]

Zenodo, the CERN supported platform, is another good practice amongst repositories. It is "open in every sense", runs and is built on Free Software. The relevant work-in-progress, open issues, and roadmaps are shared openly on GitHub and contributions to any aspect or suggestions for new features are welcome from anyone. All meta data is openly available, and all open content is openly accessible through open APIs.[63]

The Software Heritage Initiative, that is now archiving not only source code of research software, but all available software worldwide, is another great example to adopt and support in the framework of Open Science. It is a reference software repository built

[61] European Commission, Directorate-General for Research and Innovation, High Level Expert Group, First report and recommendations on the European Open Science Cloud "Realising the European Open Science Cloud", European Union 2016. Accessed 22/11/2016.

[62] Rettberg, N., European Public Sector Information Platform Topic Report No. 2014/ 10 Open Research in Europe- OpenAIRE, October 2014. Accessed 23/11/2016. For more information, see OpenAIRE.eu.

[63] See Zenodo.org.

entirely on Free Software, its development and design go through an open process, it provides persistent, long term, intrinsic identifiers, essential for reproducibility of science, and is building an international open network of mirrors in order to ensure long term availability of its archive.

Last but not least, the open knowledge policy of the JPI Climate, the EFSA (European Food Safety Agency) Knowledge Junction and the CERN Data Portal also constitute good practices of Open Science.

"Open Science" Prizes

- **An "Open Science" Prize should be established to raise awareness and promote Open Science.**

With regards to the General Findings of the Public consultation on the Science with and for Society Work Programme 2016-2017[64], under the section "Open Science", it was a general demand from the contributors that the knowledge around concepts of open data and shared data is developed; and that proposals on how Open Science could be part of reward systems and incentives for Responsible Research and Innovation (RRI) activities are explored.

The same reference is also part of the priorities scheme in the Report for the EOSC, where it is stated "[…]improve funding and rewards for open data sharing at research performing organisations and funders".[65] The FSFE considers excellence should be awarded in every case and especially, when researchers provide their scientific results for the public good.

Taking into account the existing Horizon 2020 Prizes and the increasing number of Horizon 2020 projects based on Free Software, we believe an "Open Science" Prize should be established, including secondary categories specifically intended for projects using or developing Free Software. These prizes shall reward researchers who develop software and release it as Free Software. This way, not only scientists who promote Open Science will be honoured for their work, but also awareness concerning the benefits of Open Access and Open Science will be raised among participating universities, schools, private entities and other stakeholders.

The European Commission has already taken the lead, launching the "Sharing and Reuse Awards Contest" in order to raise awareness about the benefits of sharing and reuse of

[64]European Commission, Public consultation on the Science with and for Society Work Programme 2016-2017 General Findings, Brussels February 2015. Accessed 22/11/2016.

[65]European Commission, Directorate-General for Research and Innovation, High Level Expert Group, First report and recommendations on the European Open Science Cloud "Realising the European Open Science Cloud", European Union 2016. Accessed 22/11/2016.

IT solutions in the public sector, awarding a total of €100 000 to public administrations that share and re-use Free Software solutions.[66]

In addition to its positive effects on Open Science, an "Open Science" Prize would also clearly benefit RRI.[67] RRI requires from the researcher during the whole scientific process to consider the requirements of Science For society and Science With Society,[68] in order to meet global societal needs through increased inter-disciplinary collaboration between researchers, and to conduct responsible research. The use of Free Software fully endorses the notion of RRI, because through easily verifiable and accessible research it maximises both the collaboration between researchers in various fields, and the accuracy of the results produced via research. As such, by using and endorsing Free Software, one conducts fully responsible research, making its methods available for further verification and improvement by others.

[66] "Re-use and Share" Award. See also the Open Science Prize: a new initiative in the field of health from the Wellcome Trust, US National Institutes of Health and Howard Hughes Medical Institute to encourage the prototyping and development of services that enable open content – including publications, datasets, code and other research outputs – to be discovered, accessed and re-used in ways that will advance research.

[67] Owen, R. et al.,(2012) Responsible research and innovation: From science in society to science for society, with society in: Science and Public Policy Vol. 39, pp. 751–76.

[68] Organisation for Economic Co-Operation and Development (OECD), Making Open Science a Reality, OECD Science, Technology and Industry Policy Papers, No. 25, OECD Publishing, Paris 2015. Accessed 23/11/2016.