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Open Science and Research Data Management in Horizon Europe: An Overview

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Abstract

What is new?	Open Science is considered the "modus operandi" within the EU's Horizon Europe research funding programme. However, researchers and institutions often struggle to navigate its legal provisions and practical requirements on open science and Research Data Management (RDM). This paper addresses this gap by providing a structured analysis of Horizon Europe's Open Science obligations and incentives, both in the implementation of projects and in the application process.
What was the approach?	This study examines the Open Science framework within Horizon Europe by analyzing its legal mandates, proposal evaluation criteria, and practical implementation guidelines.
What is the academic impact?	The findings contribute to the field of Research Management and Administration by offering a concise summary of the Open Science requirements in Horizon Europe.
What is the wider impact?	This paper provides actionable insights into meeting Horizon Europe's Open Science requirements, ensuring compliance, and leveraging Open Science as a strategic advantage in funding applications.

Keywords: Open Science, Research Data Management, FAIR Principles, Horizon Europe, Research Funding, Proposal Evaluation.

Introduction: What is Open Science?

Funders play a pivotal role in advancing Open Science by setting policies, providing incentives, and ensuring compliance with open access and data management requirements.

Open Science is frequently (e.g. Fecher and Friesike, 2013) defined as an umbrella term that involves various movements aiming to remove the barriers for sharing any

kind of output, resources, methods or tools, at any stage of the research process. However, there are differences in the specific components considered to be parts of open science and how these are visualized (one example: Méndez and Sánchez-Núñez, 2023); these concepts also change with time: while the European Commission (EC) used to outline eight open science ambitions (EURAXESS, 2022) it has recently switched to distinguishing between two main categories: open science practices, and open science enablers (European Commission, 2024a), summarised in Table 1.

Table 1: EC Open Science Categories

Open Science Practices	• early and open sharing of research
	  o pre-registration, registered reports, pre-prints, data deposition in shared repositories
	  o open collaboration within science and with other knowledge producers/users
	• providing immediate and unrestricted open access to scientific publications, research data, models, algorithms, software, protocols, notebooks, workflows, and all other research outputs
	• ensuring verifiability and reproducibility of research outputs
	• practicing responsible research output management (publications, data, and other outputs) in line with the FAIR (Findable, Accessible, Interoperable, and Reusable) principles
	• promoting public engagement in research and innovation, bolstering citizen science and enhancing public trust in science

Open Science Enablers	• incentives and rewards to adopt Open Science practices, e.g. the Coalition for Advancing Research Assessment (CoARA)
	• legislative and regulatory environment (EU data, copyright and digital legislative framework fit for research)
	• Horizon Europe provisions on Open Science
	• Open Science infrastructures and skills
	  o European Open Science Cloud (EOSC)
	  o Open Research Europe (ORE)
	  o support for skills and education for equitably practicing Open Science and FAIR research data management

Article 2 (5) of the Horizon Europe regulation (European Parliament and Council, 2021; more on this below) defines 'open science' as an approach to the scientific process based on open cooperative work, tools and diffusing knowledge. Globally, the UNESCO and Canadian Commission's Open Science Recommendation (2022) takes a strongly values-based approach, defining open science as: *"A set of principles and practices that aim to make scientific research from all fields accessible to everyone for the benefits of scientists and society as a whole…..Open science is about making sure not only that scientific knowledge is accessible but also that the production of that knowledge itself is inclusive, equitable and sustainable".*

Horizon Europe Legal Provisions on Open Science for Project Implementation

Horizon Europe is the European Union's flagship programme for research and innovation, running from 2021 to 2027 with a budget of €95.5 billion. The programme is structured into three main pillars: (i) Excellent Science, which supports frontier research and researcher mobility through schemes like the European Research Council and Marie Skłodowska-Curie Actions; (ii) Global Challenges and European Industrial Competitiveness, which focuses on thematic clusters and missions targeting societal needs such as climate change, cancer, and digitalisation; and (iii) Innovative Europe, which promotes breakthrough innovation, particularly through the European Innovation Council. The programme is open not only to EU Member States but also to a range of associated countries that have agreed to participate.

Given its importance as a funding source for research in the EU and beyond, its legal and technical requirements have the potential to influence research practices on a number of issues. In this article we will specifically look at the open science provisions and requirements in Horizon Europe.

Primary Sources

The basis for this exercise is a number of EU documents: on the highest level the Horizon Europe regulation (European Parliament and Council, 2021), constitutes the legal base for all activities in Horizon Europe. In this regulation Open Science is defined as the "modus operandi" for the programme and it contains a number of requirements on aspects of open science, which are further detailed in the other primary sources. On the intermediate level, the Model Grant Agreement (MGA) provides the legally-binding obligations for EU project partners ("beneficiaries"). The Annotated Model Grant Agreement (AGA) further explains these requirements in greater detail (European Commission, 2024b). Finally, the Horizon Europe Programme Guide (European Commission, 2023), lists important practical information for applicants. The following graphic (Figure 1) provides an overview of these documents, which will be quoted as primary sources in the text below.

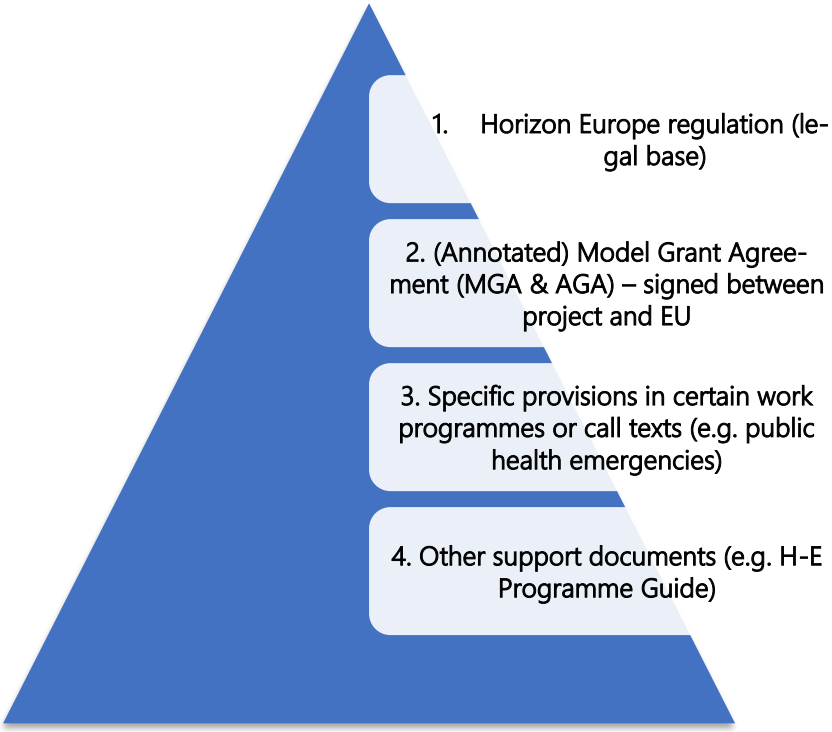

Figure 1: Sources for EU information on open science requirements in Horizon Europe (Spichtinger, 2024).

Requirements for Open Access (OA) to Publications

Open access to scientific peer-reviewed publications can take several forms. Gold open access refers to articles that are freely available immediately upon publication in fully open access journals, often requiring authors to pay an article processing charge. Green open access involves authors self-archiving a version of their article—usually the accepted manuscript—in an institutional or disciplinary repository, sometimes after an embargo period. Hybrid open access is offered by subscription-based journals that make individual articles open access upon payment, while the rest of the journal remains behind a paywall (for details see, for example, Ghent University, 2024).

The Horizon Europe regulation (articles 14 and 39) uses the wording of "ensuring" open access, which signals its mandatory nature. The Annotated Model Grant Agreement lists open access provisions as part of annex 5, "specific rules on communication, dissemination and visibility". These usually apply to all parts of the Horizon Europe Programme except the ERC and parts of the EIC. Different work programmes can also set out additional requirements.

In a nutshell, in Horizon Europe beneficiaries must *"ensure that at the latest at the time of publication, a machine-readable electronic copy of the published version or the final peer-reviewed manuscript accepted for publication, is deposited in a trusted repository for scientific publications [and that] immediate open access is provided to the deposited publication via the repository, under the latest available version of the Creative Commons Attribution International Public Licence (CC BY) or a licence with equivalent rights".* (European Commission, 2024b: 382)

This passage from the AGA quoted above not only summarises key changes *vis-à-vis* the previous Horizon 2020 programme, most notably the zero-embargo period ("immediate open access") and the open licensing requirement, but also highlights the central importance of repositories in Horizon Europe. The AGA provides an expanded definition of what a repository is but also what does not count as a repository (for details on these points see Spichtinger, 2024). The AGA also notes that:

- Beneficiaries (or authors) must retain sufficient intellectual property rights to comply with the open access mandate.
- Metadata of deposited publications must be open under a Creative Commons Public Domain Dedication (CC0) or equivalent licence, in line with the FAIR principles (in particular machine-actionable). This includes at least the following: publication (author(s), title, date of publication, publication venue); Horizon Europe or Euratom funding; grant project name, acronym and number; licensing terms; persistent identifiers for the publication, the authors involved in the action and, if possible, for their organisations and the grant.
- Only publication fees in full open access venues for scientific publications are eligible for reimbursement.
- Beneficiaries must provide information about any research output or any other tools and instruments needed to validate the conclusions of the scientific publication.

What does this mean for project implementation?

In essence, the OA requirement in Horizon Europe is a green one, that is deposition and access through a repository. However gold open access is an eligible cost as long as a copy is also deposited. Hybrid open access is not eligible for reimbursement. Horizon Europe beneficiaries may also use Open Research Europe which is an open-access publishing platform established by the European Commission to provide Horizon 2020 and Horizon Europe beneficiaries with a venue to publish their research outputs rapidly and transparently, featuring open peer review and supporting data deposition.

Requirements for Open Research Data

For open (research) data, article 14 of the Horizon Europe regulation (European Parliament and Council, 2021) also uses the language of "ensuring" but with the addition of "in accordance with the principle 'as open as possible, as closed as necessary'". It also adds that "the responsible management of research data shall be ensured in line with the principles 'findability', 'accessibility', 'interoperability' and 'reusability' (the 'FAIR principles') and that "[a]ttention shall also be paid to the long-term preservation of data".

Article 39 additionally states that open access to research data *"shall be the general rule under the terms and conditions laid down in the grant agreement, ensuring the possibility of exceptions following the principle 'as open as possible, as closed as necessary', taking into consideration the legitimate interests of the beneficiaries including*

commercial exploitation and any other constraints, such as data protection rules, privacy, confidentiality, trade secrets, Union competitive interests, security rules or intellectual property rights." Furthermore, *"[b]eneficiaries shall manage all research data generated in an action under the Programme in line with the FAIR principles and in accordance with the grant agreement and shall establish a Data Management Plan. The work programme may provide, where justified, for additional obligations to use the EOSC for storing and giving access to research data."*

This provision strengthens the open data requirements and explicitly includes requirements for research data management, most notably a data management plan (DMP). The AGA therefore contains a specific section entitled "Open science: research data management" and clarifies that the essence of the requirement is the responsible management of the digital research data generated in the action ('data') in line with the FAIR principles.

What does this mean for project implementation?

Beneficiaries must:

1. Establish (and regularly update) a DMP by month six of the project.
2. Deposit the data in a trusted repository as soon as possible and within the deadlines set in the DMP (see Spichtinger (2024) for a discussion on what constitutes a trusted repository).
3. Provide open access "as soon as possible" to the deposited data under CC BY, CC0 or an equivalent licence under the "as open as possible, as closed as necessary principle", i.e. unless this is against the beneficiary's legitimate interests, including regarding commercial exploitation; if it is contrary to any other constraints, such as data protection rules, privacy, confidentiality, trade secrets, EU competitive interests, security rules, intellectual property rights or would be against other obligations under the Grant Agreement. If open access is not provided, this must be justified in the DMP.
4. Provide information via the repository about any research output or any other tools and instruments needed to re-use or validate the data.

Furthermore, metadata of deposited data must be open under a Creative Common Public Domain Dedication (CC0) or equivalent (to the extent legitimate interests or constraints are safeguarded), in line with the FAIR principles.

Other Open Science Practices

In some cases, specific Horizon Europe Work Programmes may call for additional obligations regarding open science practices in project implementation, e.g. in a public health emergency. Such open science practices can include early and open sharing of research (for example, through preregistration, registered reports, pre-prints, or crowdsourcing); research output management (beyond publications and data); measures to ensure reproducibility of research outputs; providing open access to research outputs

beyond publications and research data (for example software, models, algorithms, and workflows); participation in open peer-review; and involving all relevant knowledge actors including citizens, civil society and end users in the co-creation of R&I agendas and contents (such as citizen science). In many cases, these practices are not mandatory but optional; however, they can provide a competitive edge in the proposal evaluation process, as discussed below.

Open Science in the Horizon Europe Application Process

The different pillars of Horizon Europe (see Introduction) have their own application processes and requirements. In this article the focus is on the requirements for pillar 2 – Global Challenges and European Industrial Competitiveness, the largest subprogramme in terms of funding and scope.

Given the legal provisions for running projects discussed above (the model grant agreement is signed at the beginning of the project) preparatory action to comply with these requirements is highly advisable in the preparation of a Horizon Europe proposal. How open science is described at the proposal stage can affect scoring both positively and negatively, and in a highly competitive programme such as Horizon Europe even a minor deduction or increase in evaluation points can make the difference between a positive or a negative funding decision.

The Horizon Europe application process begins with potential applicants identifying relevant calls for proposals, which are published on the European Commission's Funding and Tenders Portal. Each call outlines specific objectives, eligibility requirements, and submission guidelines. Once submitted, proposals undergo an evaluation by independent experts, usually based on three criteria: (a) excellence, (b) impact and (c) implementation. Each proposal is scored for each criterion on a scale from 0 to 5 (maximum total score hence 15 points). Following the evaluation, applicants receive an Evaluation Summary Report outlining the strengths and weaknesses of their proposal. Successful proposals proceed to the grant agreement preparation phase, during which the specific terms and conditions of the project are finalized. Once the agreement is signed, the project can officially commence.

As part of the process Horizon Europe applicants are provided with an application template which must be uploaded in the electronic funding and tender portal ("part B"). This template usually distinguishes between two kinds of open science practices – *mandatory* (required in running project and thus based on the legal provisions described above) and *recommended* (or *optional*) practices (not required but potentially giving you a small bonus); I discuss both categories as well as research data management provisions below, based on the information provided in the programme guide.

Mandatory Open Science Practices

Some open science practices are mandatory for all project applicants, which means the evaluation score under excellence will be lowered for not sufficiently addressing them

unless it is duly justified as not appropriate for the project (e.g. no publications or generation of research data). This concerns primarily:

a. open access to scientific publications under the conditions required by the grant agreement (see above);

b. responsible management of research data in line with the FAIR principles notably through the generalised use of data management plans, and open access to research data under the principle 'as open as possible, as closed as necessary', under the conditions required by the grant agreement;

The programme guide also notes the need to provide information about the research outputs/tools/instruments needed to validate the conclusions of scientific publications or to validate/re-use research data (though not the tools themselves) and digital or physical access to the results needed to validate the conclusions of scientific publications, unless exceptions apply. Special provisions apply in cases of public emergencies. Furthermore, specific work programmes and/or calls may specify further mandatory practices (e.g. deposition of the data in the European Open Science Cloud).

Recommended Open Science Practices

Recommended open science practices have no negative impact on the score if they are not addressed and are thus optional; however, they can increase the score under excellence if they are sufficiently addressed – this serves as an incentive. Such practices include:

- Early sharing: pre-registration, pre-prints
- Open access to software, models, algorithms
- Participation in open peer review
- Co-creation with citizens and civil society

Further definitions and examples of these are given in the Programme Guide.

Evaluation of Open Science Practices

Open science practices are usually (but not always, e.g. such as in the case of the ERC) evaluated under the 'Excellence' criterion and under the 'Quality and efficiency of implementation' criterion as well as in part A (administrative information) as follows:

- Under the 'excellence' part of their proposals, in the section on methodology, proposers should describe *how* open science practices (mandatory and recommended, as appropriate) are implemented as an integral part of the methodology and show how their implementation is adapted to the nature of their work. If open science practices are not applicable to the proposal, justifications should be provided.
- Under 'capacity of participants and consortium as a whole', proposers should describe how the consortium brings together the necessary disciplinary and interdisciplinary knowledge. Proposers should show how this includes expertise and/or track

record in open science practices, relevant to what is planned for the project. (If justification has been provided that open science practices are not relevant for their projects, it is not necessary to demonstrate track record and expertise.)

- Finally, in part A of their proposals (administrative information), proposers are asked to list up to five relevant publications, widely-used datasets or other achievements of consortium members that they consider significant for the action proposed. Open access is expected for these publications, in particular journal articles, while datasets are expected to be FAIR and 'as open as possible, as closed as necessary'.

Research Data Management in the Proposal

The Horizon Europe proposal template usually treats research data management as a related but distinct point to open science. Applicants generating and/or collecting data and/or other research outputs (except for publications) during the project must provide maximum one page on how the data/research outputs will be managed in line with the FAIR principles addressing the following:

- Types of data/research outputs (e.g. experimental, observational, images, text, numerical) and their estimated size; if applicable, combination with, and provenance of, existing data.
- Findability of data/research outputs: Types of persistent and unique identifiers (e.g. digital object identifiers) and trusted repositories that will be used.
- Accessibility of data/research outputs: Intellectual property rights considerations and timeline for open access (if open access not provided, explain why); provisions for access to restricted data for verification purposes.
- Interoperability of data/research outputs: Standards, formats and vocabularies for data and metadata.
- Reusability of data/research outputs: Licences for data sharing and re-use (e.g. Creative Commons, Open Data Commons); availability of tools/software/models for data generation and validation/interpretation /re-use.
- Curation and storage/preservation costs; person/team responsible for data management and quality assurance.

Proposals selected for funding under Horizon Europe will need to develop a detailed data management plan (DMP) for making their data/research outputs FAIR during the project as a deliverable by month 6 and revised towards the end of a project's lifetime. While there is no obligatory form for the DMP, the EC and the ERC do provide a (slightly diverging) optional template. Furthermore, a number of electronic tools exist to assist in the creation of Horizon Europe compliant DMPs (such as ARGOS, the Data Stewardship Wizard or DMP Online).

It should also be noted that the Programme guide contains a list of helpful links and sources for both the open science and data management sections in the proposal.

Conclusions

Funders play a crucial role in promoting open science by incentivizing researchers and institutions to adopt open practices. The European Commission has recently streamlined its approach by distinguishing between Open Science practices—such as early sharing, open collaboration, and responsible research data management—and enablers, including policy incentives, legal frameworks, and dedicated infrastructures like EOSC and Open Research Europe.

The legal provisions within the EU's Horizon Europe research funding programme, particularly regarding Open Access to publications and Open Data, reinforce a mandatory commitment to transparency, accessibility, and reusability of research outputs. Key elements such as immediate Open Access, the use of trusted repositories, and adherence to the FAIR principles set clear obligations for researchers.

Open Science practices are also integrated in the funding application process, thus impacting the competitiveness of proposals. The inclusion of both mandatory and recommended Open Science practices highlights the European Commission's dual approach: enforcing minimum requirements while encouraging researchers to go beyond.

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BIOGRAPHY

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