European Commission

Mutual Learning Exercise: Open Science – Altmetrics and Rewards

Implementing Open Science: Strategies, Experiences and Models

Thematic Report No 4

December 2017

Research and Innovation

MLE on Open Science: Altmetrics and Rewards - Implementing Open Science: Strategies, Experiences and Models

European Commission
Directorate-General for Research and Innovation
Directorate A — Policy Development and Coordination

Contact (H2020 PSF MLE OPEN SCIENCE):
Ana CORREIA, Coordinator of the MLE on Open Science, Unit A.4 - Ana.CORREIA@ec.europa.eu
Irmela BRACH, Senior Policy Officer, Unit B.2 - Irmela.Brach@ec.europa.eu
René VON SCHOMBERG, Team Leader, Unit A.6 - Rene.VonSchomberg@ec.europa.eu

Contact (H2020 PSF coordination team):
Román ARJONA, Chief Economist and Head of Unit A4 - Roman.ARJONA-GRACIA@ec.europa.eu
Stéphane VANKALCK, PSF Head of Sector, Unit A4 - Stéphane.VANKALCK@ec.europa.eu
Diana SENCZYSZYN, PSF Team Leader, Unit A4 - Diana.SENCZYSZYN@ec.europa.eu

European Commission
B-1049 Brussels

Manuscript completed in December 2017.

EUROPEAN COMMISSION

Mutual Learning Exercise: Open Science – Altmetrics and Rewards

Implementing Open Science: Strategies, Experiences and Models

Thematic Report No 4

Prepared by the independent expert: Sabina Leonelli

Directorate-General for Research and Innovation

2017 EN

Table of Contents

List of tables

1 INTRODUCTION

This report has been developed following the 4th Working Meeting of the participants of the Mutual Learning Exercise (MLE) on Open Science, which was hosted in Zurich, Switzerland on 10-11 November 2017. It reviews the current state of play in developing and implementing national policies and related actions aimed at incentivising researchers and research institutions to engage with Open Science. The purpose of this report is:

- To outline key priorities and principles underpinning the future implementation of Open Science at the national level;
- To review existing experiences in developing and supporting Open Science activities and related policies among those member states participating in the MLE;
- To summarise strategies, lessons learnt and models proposed so far; and
- To propose a roadmap for researchers, funders, research institutions and national governments that can help to guide such implementation across the member states.

2 MLE METHODS AND SOURCES

The goal of this MLE is to facilitate communication and reciprocal learning across member states and between member states and EU policymakers and Open Science experts. The starting point for this exercise is the fact that member states vary considerably in their approach (or lack thereof) to Open Science and, partly due to the very diversity in science policy and research governance among countries, there is no well-established baseline for how Open Science implementation should look. This MLE turns this diversity into a virtue by facilitating learning from concrete experiences across member states, thereby exchanging know-how and fostering understanding of the implications, advantages and disadvantages of different strategies to support and incentivise Open Science.

This report builds on this exchange of experiences, both positive and negative, and provides an overview of various models of Open Science implementation across Europe, which include different stakeholders and research communities. Specifically, the report builds on five sources of information:

1. The findings of the previous (3rd) MLE report which highlighted the key concerns and challenges to implementing Open Science;
2. A review of relevant background literature and policy documents outlining current and past activities undertaken at the European level and within member states to support and incentivise Open Science;
3. Presentations on specific national initiatives and European reports provided by invited speakers during MLE meetings and country visits to Finland, Croatia and Switzerland;
4. Discussions among MLE participants on how Open Science can and should be implemented and fostered. These took place during the previous MLE meetings and in particular in Dubrovnik in September 2017, and are documented through notes from group rapporteurs which have been gathered together by Katja Mayer; and
5. Responses provided by MLE participants to a questionnaire sent out in June 2017 specifically to solicit specific examples and perspectives on the current state of affairs across the member states. It included five open-ended questions about experiences in implementing Open Science within the member states, which reflect the situation in those countries during the summer of 2017. The responses

from the MLE participants were compiled by Sabina Leonelli in summer 2017. These questions and answers are reported in full in the appendix to this paper.

3 OPEN SCIENCE IMPLEMENTATION: PRIORITIES AND PRINCIPLES

This section provides the basis for the analysis of national experiences and strategies to follow. First, it reviews the goals that member states aim to achieve by implementing Open Science, thereby clarifying the reasons why these countries consider this to be an attractive and worthwhile endeavour (section 3.1). Secondly, it identifies the key principles needed to inform research governance to achieve a successful transition to Open Science (section 3.2). These principles need to be singled out and discussed by any stakeholder engaging with Open Science guidelines and practices, since the adoption of different or contrasting principles may lead to different outcomes, including serious challenges from the research community and failure to achieve some or all of the goals outlined in section 3.1.

3.1 Priorities for Member States

The previous MLE report identified and discussed member state concerns about the implementation of Open Science. As a follow-up to this discussion, these countries expressed a strong interest in practical examples that could help to make a "case for change" and provide a model; and concrete, stepwise guidelines around targets and timelines for Open Science implementation. The first step towards such a roadmap is clarification of the goals Member States hope to achieve through the implementation of Open Science – since, as argued by a recent report by the Organisation for Economic Co-operation and Development, 'Open Science is a means, not an end' (OECD 2015). Building on the concerns mentioned in the previous MLE report and further discussions among MLE participants, the following priorities emerged as common ground and the desired outcome for all member states:

- *Achieve Open Access to publications*: this is universally seen as an important first step towards Open Science, which many countries are already successfully pursuing (see section on experiences below);

- *Go beyond Open Access and take advantage of other aspects of Open Science*, including Open Data, Methods and Education. However, this involves very different activities and strategies than fostering Open Access, and requires dedicated efforts and investment;

- *Shift to multiple indicators for research assessment*: the use of multiple indicators, including both quantitative and qualitative metrics, is recognised as being more effective and reliable in fostering Open Science activities, in line with advice from expert groups. However, it is also more expensive to implement and requires a break with existing assessment systems for many countries;

- *Clarify responsibilities*: decisions need to be taken, in consultation with all stakeholders, on who is responsible for which aspects of Open Science implementation, how such efforts can be supported and monitored, and by whom. These decisions should be taken together with, or at the very least in parallel with, discussions around implementation of the European Research Area roadmap. A national agenda for Open Science needs to be implemented, involving a well-defined division of labour, clear points of contact and accountability, and regular venues for discussion and monitoring progress (see section 4.1);

- *Evaluate investments in infrastructure and resourcing*: an assessment of costs and the infrastructure required to guarantee long-term sustainability of the Open Science system must be carried out, and budgets redirected accordingly;

- *Clarify legal framework* relating to Open Science, particularly intellectual property regimes linked to research outputs (including data, techniques and software);

- *Coordinate with European governance and other member states*: member states should rely on well-coordinated and clearly formulated Open Science policies, goals and infrastructure at the European level, which would function as role models and guidelines for what these countries need to contribute;

- *Involve researchers and research organisations in all aspects of Open Science implementation,* thereby making sure that participants and relevant stakeholders are fully engaged in the process, and that the process of implementation works for them;

- *Prioritise public engagement in Open Science activities,* including citizen science initiatives, engaging members of the public in research planning and assessment, and the inclusion of diverse sources of expertise in academic research.

- *Enhance research outputs and quality*, thus making research within each country more competitive, improving the visibility of researchers and collaborations with industry both nationally and internationally.

- *Support early-career researchers and prevent the brain drain:* early-career researchers are most directly affected by transitions in assessment and guidelines for Open Science, and are most vulnerable to evaluations that ignore the efforts involved in making research open (as sometimes performed by senior academic circles involved in peer reviewing and funding assessments). Early-career researchers are also the most likely to benefit from evaluation systems that privilege Open Science behaviour, such as collaboration in teams, professional service and data curation efforts. The implementation of such systems can help to improve the working conditions, support and resourcing available to researchers. In turn, improvements in the research environment can help to prevent the brain drain experienced by some member states (understood as the migration of top talent abroad, without a corresponding influx of excellent foreign researchers), as well as preparing researchers for jobs outside academia;

- *Monitor the transition to Open Science and address emerging concerns in a timely and efficient manner*: it is crucial to use the transition to Open Science as an opportunity to hold regular discussions on scientific governance with relevant stakeholders, including on the needs of different research fields, cultural and language issues, and infrastructural demands.

3.2 Key principles

Another important ingredient when strategising on how to foster Open Science in practice is the ability to identify guiding principles upon which activities and choices can be anchored. Principles can provide important guidance on how to apply general guidelines to local situations, in ways that foster the achievement of the goals outlined in the previous section. The following principles emerged from MLE discussions as important and broadly agreed as a means of underpinning and guiding efforts to implement Open Science policies:

- **Respect for diversity**

  It is crucial to respect epistemic cultures and diversity in expertise and skills by paying close attention to how Open Science practices affect local research cultures and methods, smaller research communities, natural as well as social sciences and humanities, and groups working in languages other than English. Research works best when involving different actors with different qualities, and the incentive system must recognise and reward such diversity. Furthermore, buy-in from researchers themselves is necessary for Open Science policies to work. In the words of MLE participants: *"I believe that the OS policy cannot be imposed, but that it must be achieved through dialogue with the academic community"; and "I don't think it is useful or realistic to go against the natural aspirations of researchers, of what drives them. One example is demanding the sharing of data that is destined to support a*

publication if such sharing could endanger the establishment of their scientific priority on the subject or if there are no adequate incentives for sharing such data, such as being given merit in the assessment procedures or when applying for funding. Of course, this all depends on the research area and type of communication that each discipline favours (and for some of them data itself is the main output of research to be communicated), but for a great deal of them it would be more realistic to demand the sharing of data at the moment of the first publication."

- **Collaboration**

  Open Science can only be realised through collaboration among different institutions, research fields, stakeholders (including funders, universities, government departments, libraries and learned societies) and countries (both within and beyond Europe).

- **Accountability**

  Stakeholders in Open Science need to explicitly and clearly take responsibility for different aspects involved in its implementation, and be accountable for the degree and mechanisms through which these aspects are achieved.

- **Transparency**

  Debates and decision-making around Open Science need to be transparent and publicly accessible, making it possible for any stakeholder (including the general public) to engage in the ongoing discussions and understand the rationale behind specific actions and guidelines. Attention must be paid to how information on Open Science implementation is presented, and adequate support must be given to the development of publicly accessible information tools.

- **Social responsibility and engagement**

  Ethical and social concerns, as well as consultation and mechanisms for social participation, need to be incorporated into the implementation of Open Science *at every stage*. Particular attention must be devoted to ethical concerns around research data management and dissemination (and related infrastructures).

- **Fairness**

  Open Science stakeholders need to counter the high resource bias characterising many current Open Science activities by making sure that actions are targeted at the diverse needs and situations in different countries and research fields – and that English-speaking countries do not benefit disproportionately from the implementation of Open Science repositories (which are typically set up in English and currently mainly include resources in that language). In recognition of the fact that different countries have different priorities and allocate a different value to scientific research and its place in society and economic development, the principle of fairness does not imply equality in outputs and resources. At the same time, it is important that each country actively contributes in ways commensurate with its resources, thereby making Open Science a joint effort in which each member state has a chance to make a difference.

- **Impact**

  Open Science is about improving the quality, accountability and social contribution of research while striving to minimise bureaucratic and administrative burdens on researchers and research institutions.

4 OPEN SCIENCE STRATEGIES, EXPERIENCES AND MODELS

Having outlined the goals and guiding principles for Open Science implementation, this section now assembles some of the key experiences, strategies and models highlighted by MLE participants as useful in achieving these goals. These insights and examples are arranged under five main headings: (1) the importance of national Open Science strategies; (2) publishing strategies; (3) strategies that connect publication venues with mechanisms for evaluating research; (4) funding strategies; and (5) the role of participation in European and international Open Science activities.

In addition to the three previous reports produced within the MLE for Open Science (Holmberg 2017a/b, Leonelli 2017), there are two other useful sources of relevant data and experiences on Open Science implementation: the report on Open Science published by the Organisation for Economic Co-creation and Development in 2015, which includes examples from non-European countries (OECD 2015); and the European Commission's Open Science Monitor, which provides a state-of-the-art overview of Open Science policies across EU member states[1].

4.1 The importance of national Open Science agendas

To date, not all member states participating in the MLE have adopted an explicit national agenda for Open Science. Participants agreed that establishing such a national agenda is crucial to the development and coordination of strategies for the implementation of Open Science by funding agencies, research institutions, learned societies and publishers. This is particularly the case for countries where the state plays a significant role in the governance of research institutions, such as for instance, Croatia, Latvia, Slovenia, Moldova and Italy. Countries where research institutions have a large degree of autonomy from the state, such as Switzerland, Sweden and the Netherlands, are less affected, although even there the presence of a national agenda with clear priorities and division of labour greatly facilitates coordination among stakeholders.

It is too often the case that some groups of stakeholders (often researchers) invest considerable effort in a specific strategy for Open Science implementation, without coordinating with other stakeholders and without the overt backing of government or international agencies. In those cases, there is a high risk of remaining invisible at the national and international levels, and thus of failing to advance the overall development of Open Science in Europe. For such 'bottom-up' initiatives to become visible and create useful models and learning experiences for others, member states must:

1. Implement a national Open Science strategy matching that outlined by the European Commission, and

2. Establish clear points of contact and coordination which can ensure constructive and fruitful dialogue and collaboration among all stakeholders.

This is easier and most effective to implement in small countries with centralised governance, such as Latvia, Moldova and Slovenia, where in principle at least, it is possible to gather together many of the relevant stakeholders in the same place. This is more complex in countries with a federal or divided structure, such as Belgium and Switzerland. The establishment and implementation of a national agenda is therefore likely to vary considerably across countries. The presence of informal networks, such as the Open Access Research Network in Austria OANA, can be of considerable assistance for acquiring and coordinating feedback and input for governmental action.

[1] http://ec.europa.eu/research/openscience/index.cfm?pg=home&section=monitor

Finland and the *Netherlands* are examples of countries that have already instituted a clear national agenda, thereby boosting efforts among national stakeholders to abide by the agenda, and providing a rallying point for debate and constructive exchange around the choice of relevant tools, mechanisms and practical investments. The key ambitions listed in the Dutch plan for Open Science are geared towards practical outcomes, as follows: (1) full open access to publications in 2020; (2) make research data optimally suited for reuse; (3) institute recognition and rewards for Open Science behaviour; and (4) promote and support Open Science via the provision of information and training. The Finnish vision for Open Science places more emphasis on central principles, leaving more freedom for stakeholders to decide on the specific steps to be adopted (Finnish Open Science Roadmap 2017). It includes the following tenets: (1) reinforcing the reliability and quality of science and research; (2) strengthening openness-related expertise which already exists in Finland; (3) ensuring a stable foundation for the research process by establishing basic structures and services; and (4) increasing the social impact of research by creating new collaborative opportunities for researchers, decision-makers, business, public bodies and citizens.

Sweden is now in the process of finalising its own national agenda, which was formulated in the Research Bill of November 2016. The National Library of Sweden and the Swedish Research Council have received a government assignment to nationally coordinate Open Access to publications and research data. The government of *France* is also taking practical steps, most notably by implementing a new legal framework that enables researchers to publish their last pre-print wherever they want, thereby giving legal security to green Open Access publishing and secondary publication or pre-prints. France is now developing a communication strategy to explain to stakeholders how to use this framework. *Portugal* is also developing a plan for Open Science in line with the ERA roadmap, which is in its early stages of discussion and implementation (http://www.ciencia-aberta.pt/); and *Bulgaria* discussed and approved a national Open Science strategy in parliament in the summer of 2017.

In highly federated countries, research institutions tend to have a higher degree of autonomy with respect to central government, and are thus playing an important part in fostering Open Science developments at the national level. This is true of *Switzerland*, where the federal government simply mandated that Swiss universities develop their own Open Access strategy in collaboration with the Swiss National Science Foundation[2]. The Swiss National Research Foundation is also playing a leading role by fostering debate around Open Access and Open Data, not least by developing the National Open Access Strategy and mandating data management plans (DMPs) for all projects funded from 2018 onwards. Similarly, in *Austria*, the Federal Ministry of Science, Research and Economy (BMWFW) has promoted the initiative 'Austrian Transition to Open Access – AT2OA' by funding 21 universities to work together towards achieving this goal.

While there is an Open Science mandate in *Belgium*, which is coordinated by the Belgian Science Policy Office (BELSPO), its implementation is complicated by the need to coordinate different governments, especially since universities are governed at the regional rather than the national level. In *Flanders*, there is a particularly active discussion around implementing Open Data through mandating DMPs for publicly funded research, thereby fostering the implementation of Open Data at the regional level.

There are instances where bottom-up Open Science initiatives are overtly clashing with national research governance systems, and this is where discussions on Open Science implementation at the national level are most urgently needed. A case in point is *Croatia* where, although there are multiple sophisticated initiatives by researchers and research

2 https://www.swissuniversities.ch/fileadmin/swissuniversities/Dokumente/Hochschulpolitik/Open_Access/Open_Access_strategy_final_e.pdf

institutions (see below), national research evaluation continues to privilege quantitative metrics, such as the number of publications and impact factors.

There are also cases where national strategies have yet to be implemented, or are hard to implement because of a Member State's specific political situation. In *Slovenia,* for example, a novel legislative framework and governmental buy-in is needed to support the many Open Science activities by research institutions and learned societies. In *Armenia*, for instance, there are no extensive and explicit plans at the national level yet, although steps are being taken to develop a national Open Access strategy and a related repository for Open Access publications. Countries which are less advanced in their implementation of Open Science have the advantage of being able to learn from other experiences and implementing several useful steps at the same time, such as including Open Science incentives into future funding-allocation strategies.

4.2 Publishing strategies

A key strategy for the practical implementation of Open Science is the establishment and maintenance of publication avenues where researchers can deposit their outputs, ranging from full articles to data, protocols and other results of their work. The institution of policies and repositories fostering Open Access to research articles, often by disseminating pre-prints and listing Open Access journals that are not easy to find online, is typically the first step in the national implementation of Open Science.

Moldova, for instance, is starting work in this area by developing a national Open Access repository which may enhance the visibility of Moldovan research abroad and showcase the advantages of openness to researchers and research institutions. In *Slovenia* and *Croatia*, efforts towards the implementation of Open Access are in full swing. The central repository of Croatian scientific journals HRCAK, which gives access to over 300 Open Access journals and 80 000 articles, is a particularly good example of best practice. The HRCAK platform is being developed further to become a scalable national infrastructure including publications, projects and also software as a service for feedback and co-design. Solution-oriented communication among all relevant stakeholder groups works very well in this case. Notably, the project is financed by EU development funds and its adoption at the national level is under discussion. The Croatian Declaration on Open Access (http://www.fer.unizg.hr/oa2012/deklaracija) has been supported by around 20-30 institutions since 2012. However, more work is needed before it is fully accepted within the academic, research and business communities.

Several research institutions in *Belgium* (e.g. Institute for Health Care Research, Belgian Nuclear Research Centre, Royal Library of Belgium) are setting up Open Access- and Open Data-compatible library systems. They consult BELSPO in this matter and share experiences and best practices, although national-level support for such initiatives has yet to be substantiated. Initiatives by other institutions across Europe are also focusing on Open Data. One example is the Swiss Centre of Expertise in the Social Sciences (FORS), which provides a service for storing and using research data in the relevant disciplines in *Switzerland*.

4.3 Connecting publishing and evaluation strategies

Some MLE countries are trialling systems that connect the opportunity to make research outputs openly available with the evaluation of researchers who produce such outputs. This approach is already being implemented in countries like Norway, where the national database CRIStin also acts as evidence for the performance-based funding system (Holmberg 2017b)[3]. This link between publishing and evaluation strategies is promising in several respects:

[3] www.cristin.no/english/

- It provides a strong incentive for researchers to deposit all their results in an Open Access repository;

- It reduces the administrative burden on researchers by giving them one system in which to list their outputs (instead of having to input the same outputs in several different systems, depending on the number of funders and the institutions with which researchers are working, as is more typically the case);

- It reduces the administrative burden on research institutions and funding bodies, which can rely on one system for the acquisition of data on research productivity instead of having to develop and manage their own systems.

One institution which has successfully implemented this system is the University of Liège in *Belgium*, where researchers are evaluated solely on the basis of the outputs they add to their Open Access institutional repository (which includes Green Open Access, i.e. pre-prints). For such a system to work successfully, the university's rector must be strongly supportive, particularly since the system is bound to be criticised by researchers when first introduced. The University of Liège's Open Access team, and in particular the library's director, made a considerable effort with communication and awareness-raising in order to facilitate the widespread adoption of this system by researchers and administrators. Some institutions in *Switzerland* are also using Open Access repositories as the basis for their internal research assessment, although the central government does not take Open Access criteria into account when allocating funding in the context of its basic contributions to the cantonal universities. The University of Bern, for instance, hosts a publishing platform used to submit publications and data both for Open Access and for evaluation (https://boris.unibe.ch/).

In several MLE member states, excellent Open Access infrastructure is being developed which could also be used for evaluation, although in many cases governmental policy on research evaluation discourages this. *Croatia* is a good example. The Croatian scientific bibliography CRSOSBI (https://bib.irb.hr/) contains more than 450 000 bibliographic records, allowing scientists to archive full-text articles in Open Access. The DABAR tool was set up in 2014 as a scalable, long-term digital infrastructure collecting user profiles and Open Access outputs from the research community. It has been adopted by 10 universities so far, and has incorporated two national repositories and 115 digital repositories. However, these tools have yet to be implemented for the purposes of evaluating Croatian researchers because the depth and richness of the information they provide is irrelevant to the existing governmental mechanism for research evaluation, which focuses on impact factors and citations. A similar situation exists in *Slovenia* where the COBISS/SciMet tools (http://scimet.izum.si/; http://home.izum.si/COBISS/bib/Help_SI_en.html) have been developed to capture researchers' outputs and personal bibliographies. Additional functionalities to monitor the performance of publications were integrated in 2016 through the combination of Altmetric.com and PlumX. At the same time, however, *Slovenia* is taking practical steps towards a critical evaluation of whether such metrics can help foster excellence in science and Open Science behaviour.

4.4 Funding strategies

There was a general consensus among MLE participants that using Open Science as a criterion for allocating funding would make a significant and immediate difference in the behaviour of researchers and research institutions. This belief is underpinned by the experience of countries that have implemented this strategy, such as the *UK* and the *Netherlands*, where the percentage of research being made openly available has dramatically increased over the last five years. This shift is associated with enhancing international visibility, higher citation counts and broader readership, as discussed in previous MLE reports. Funding mechanisms can play a particularly significant role in changing the culture of the journal-impact factor as a key measure of research excellence, as well as fostering better research planning, as demonstrated by the requirements for a DMP.

Since 2010, public funders in *Sweden* have made Open Access publishing mandatory. Sweden is also discussing a shift in funding allocation practices to take account of Open Data, for instance by requiring that all data produced in publicly sponsored research are made findable, accessible, interoperable and reusable (FAIR). One mechanism under discussion is the development of a FAIR indicator which would signal compliance and allow for swift monitoring.

In *Switzerland*, the Swiss National Science Foundation is making DMPs a mandatory, formal requirement for all grant applications submitted from October 2017 onwards. The DMPS are not part of the evaluation but must be submitted along with the research proposal. The criteria a DMP needs to fulfil are very broad, in an effort to respect the differences between fields and the diverse requirements of data obtained on different research objects (e.g. living organisms versus minerals or weather patterns). As in the case of DMPs required by the European Research Council and other funding bodies across Europe, the DMP is to be updated and revised during the ongoing project. At the end of the project, a final version of the DMP will be made publicly available in the SNSF's online database of funded projects.

Another strategy through which funding mechanisms could enable Open Science is the provision of 'funding bonuses' to research institutions that comply with Open Science mandates. This strategy has been successfully pioneered by *Finland* and is now under consideration in *Sweden*, *Germany* and the *Netherlands*. A key factor in its success is the possibility to tailor the type and monetary value of such extra support to the specific circumstances and budget of each member state, as often incentives that are relatively small in value go a long way towards providing motivation and signalling institutional support for Open Science activities.

4.5 Participation in international Open Science initiatives

Yet another way for member states to engage in Open Science implementation is through participation in relevant ongoing international initiatives, which can provide guidance, motivation, expertise and support (as well as making national efforts internationally visible). This strategy has the advantage of resulting in policies and actions that align with those of other countries, which is particularly important given the international nature of research itself and the high degree of researcher mobility.

From the practical perspective, a key strategy adopted by member states – and particularly those who have a relatively small capacity to develop in-house infrastructures and systems – is to engage in international initiatives aimed at developing Open Science tools and skills, and provide relevant information and training. One such initiative is OpenAIRE (www.openaire.eu), a well-established and highly successful Seventh Framework Programme project that created a network of 50 partners across Europe to support the implementation of Open Science through three main types of activity:

1. Building support structures to enable researchers to deposit FP7 publications, through the establishment of 27 national Open Access desks;

2. Establishing a digital infrastructure to host articles (pre-print or originals, depending on copyright);

3. Working with specific research communities to explore the requirements for Open Science implementation across fields.

Researchers and institutions in *Latvia* and *Lithuania* have assumed a strong role in the development of OpenAIRE, which has provided a reference point for political and administrative discussions around the benefits and requirements of Open Science. Initiatives such as OpenAIRE have the potential to provide the overarching infrastructure, practical guidance and training required to implement Open Science at the national level. Valorising these initiatives, and securing their future development and maintenance after

their initial funding ends, is crucial to enabling well-coordinated and fruitful engagement with Open Science activities across and beyond Europe.

From the political perspective, it is imperative that Open Science activities at the national level proceed in close dialogue with the European Research Area national roadmaps, which provide an excellent opportunity to create consensus around specific measures and momentum underpinning their implementation. This also ensures that there is no duplication of efforts by policymakers and other stakeholders when tackling science governance and future investments in research and innovation. Groups such as the ERA Standing Working Group on Open Science and Innovation (https://era.gv.at/directory/243), which was created in 2016 by merging the ERA task forces on Open Data and knowledge transfer, constitute excellent venues for European member state representatives to discuss and coordinate their activities, and to provide input to ongoing international efforts, such as the European Open Science Cloud (EOSC).

Finally, it is important to note the role played by some national science consortia and academies in encouraging Open Science activities and enabling international dialogue and engagement by researchers. Notable among these organisations are the Academy of Science in *Moldova*, which has taken a lead in spurring Open Science engagement in that country, and the Austrian Open Access Research Network OANA (http://www.oana.at/en/home/), which has also become the unofficial site for relevant debates at the national level.

5 LESSONS LEARNT AND KEY CONCERNS

5.1 Comprehensive nature of Open Science implementation

The experiences reported in the previous section highlight how opening up publications is a relatively easy step forward which can be implemented without major disruption to existing research cultures. Much more challenging is the introduction of other aspects of Open Science, such as Open Peer Review, Open Data and Open Methods, which require substantial disruption and cultural changes for both researchers and research institutions. MLE participants discussed how currently there seem to be two approaches to Open Science implementation:

1. One that simply supports the status quo by encouraging more openness, building related metrics and quantifying outputs, and

2. Another that experiments with alternative research practices and assessment, open data, citizen science and open education.

MLE participants agree that, while achieving Open Access remains an important priority, Open Science is an opportunity to reorganise the science system as a whole, and challenge some of the least productive aspects of current research practice and evaluation. In the words of one delegate: "*The most important lessons learnt are that Open Science uptake needs a comprehensive approach addressing every aspect, from assessment to infrastructures to incentives, in order to be effective. If only some components of the system are addressed, any approach is very likely to fail. Honesty, transparency and making abundant information available to all stakeholders, particularly researchers, is crucial. The comprehensive approach must also extend to the range of stakeholders involved, with the engagement of all major research stakeholders. In particular, the full involvement of researchers' right from the start of Open Science policy design and implementation is mandatory*." This was also emphasised by a speaker from the European Commission at the meeting in Dubrovnik, who highlighted how rewards in Open Science are about changing the way research is done, who is involved and how it is valued. Small fixes are not enough: implementing Open Science requires systemic and comprehensive change in science governance and evaluation.

5.2 Dealing with costs

Open Science implementation is expensive, both in terms of the infrastructures required and the human resources and specialist expertise that must be developed, mobilised and maintained in order to support researchers in this endeavour. Many MLE participants are worried that money going to Open Science is being taken from other places, most often research budgets, which may damage science by further reducing the already small amounts of public spending devoted to it. There are several possible answers to this concern.

One is to bite the bullet and concede that implementing Open Science means diverting some of the core research budget to it for support and infrastructures. While potentially disruptive to scientific productivity in the short term, this is likely to boost the efficiency, productivity and impact of research in the long term, thereby justifying the expense. This also means better deploying those research budgets devoted to scientific publishing and communication, which already include as much as one-third of the overall research budget and yet are used to sponsor publishing venues that most people cannot access. This option must be evaluated in relation to the public funding available for research in each country, as it may prove problematic particularly where public spending is barely enough to cover researchers' salaries. Negotiations around Open Science budgets may present an opportunity for each country to reconsider and increase public investment in

research and innovation, particularly given the social and economic advantages likely to be created by Open Science activities (Leonelli 2017).

Another response is to acknowledge that the money spent on Open Science infrastructure is not only an investment in openness, but also and most importantly is a way to tackle the pressing issue of data storage and communication, which is affecting research and innovation efforts as a result of the latest advances in big data and digitalisation efforts (and regardless of the Open Science agenda). A crucial question for member states is whether the services and technologies deployed to provide digital support for research efforts should be fully privatised (as in the use of Amazon or Google cloud services), or whether public entities should support their own services, as envisaged by the EOSC. The latter option would enable research outputs to remain publicly goods, available to all in a transparent and regulated way, and make publicly funded science less dependent on pricing models determined by private companies. This point was stressed by Axel Marion's presentation on behalf of swissuniversities during the MLE meeting in Zurich. He highlighted how the investment required for scientific publication and infrastructure in the long term is projected to be much higher if the current system is maintained without changes, than if investments are made in the shorter term to implement Open Science.

A third response is to build upon the infrastructure that already exists – or is being developed – at the international level, as mentioned in section 4.5 above, be it in the form of general repositories and training or discipline-specific initiatives. This is a priority for large countries where setting up a national infrastructure is costly and significantly long term, as demonstrated for instance by the challenges encountered by the UK in setting up the Researchfish infrastructure for sharing outputs among researchers receiving funding from UK Research Councils[4]. This is also a solution for small countries or countries where the national budget for research is at the minimum. At the same time, it is important to stress that adopting and making use of international infrastructures and training schemes still requires some minimal investment from member states, at least to foster awareness and relevant training and incentives within public institutions, funding bodies and research-performing organisations. Furthermore, European initiatives, such as the EOSC, which is a crucial component of long-term Open Data infrastructure, will require participation – often in the form of manpower and investment – from each member state to be able to function properly.

Finally, it is important to note that while Open Science per se cannot solve the issue of who pays and for what, it can shift perspectives on collaborative investments, impact and codes of conduct. Open Science behaviour can improve the distribution of research investments, bring more transparency to how funding is utilised and maximise the value of existing or past initiatives, thus providing a more efficient platform for public and private spending in research and innovation.

5.3 Educating and involving government officials

Many MLE participants pointed to the significance of educating public officials, including high-level policymakers, in the advantages and practical implications of Open Science. Although this is not an easy task given the technical nature of some Open Science debates, greater awareness of its potential for society lies at the core of adopting Open Science within national policy. Training based on existing policy documents, including this report and others produced by the MLE, will be crucial in this respect, and can be organised relatively easily given the abundance of relevant sources of information and expertise within international and national research and policy communities.

[4] https://www.researchfish.net/

5.4 Coordinating top-down and bottom-up initiatives within and across member states

Member states vary dramatically in the ways in which they develop and implement science policy and research management, particularly the impact and visibility of bottom-up initiatives on top-down policy at government level. The implementation of Open Science calls for international, coordinated action, and several bottom-up initiatives are providing a platform and venues for relevant debate. The European Commission also regularly sponsors international meetings, conferences, projects (such as OpenAIRE) and infrastructures (like the EOSC) within which the implications of Open Science policies and avenues towards implementation can be discussed across national boundaries. Yet, there is relatively little interaction among national governments over how Open Science can be implemented and coordinated.

One significant initiative is the above-mentioned ERA Standing Group for Open Science and Innovation which provides an excellent venue for member states to discuss and coordinate their policies and contributions to international activities such as the EOSC. Another important grouping is the senior National Academies of Science with the junior National Young Academies, which typically includes representatives from all research disciplines and fields. National Young Academies, together with the Global Young Academy, have proved highly engaged in Open Science activities and a very useful platform for consultation on how current changes in the research system are likely to affect researchers on the ground, as well as their outputs and engagement with wider society. Sweden, for instance, is making extensive use of the Swedish Young Academy to set up its national Open Science agenda. The European Young Academies and the Global Young Academy have released two joint position statements on Open Access and Open Data, which provide useful starting points for consultations with researchers (European and Global Young Academies 2016a/b).

Increasing interaction among member states would help to tackle and distribute the costs related to Open Science implementation, and support the long-term sustainability and resilience of repositories and data infrastructures (for instance, by making sure that they are stored on multiple servers and facilities across countries).

5.5 Tackling the role of publishers

MLE participants pointed to public debate and more clarity over the role of publishers in scientific governance as a major element of Open Science implementation. At the moment, most research articles are published by a handful of large commercial publishers (referred to as an oligopoly, Larivière et al. 2015), which have effectively taken over publishing procedures for the most reputable journals in several fields and have the power to affect the business models and reviewing practices adopted even within non-commercial publishing ventures (Fyfe et al. 2017). This is generating a backlash among the research community, the reasons for which were effectively summarised by one of the MLE participants as follows: "*it simply is not ethical to publicly fund research whose results will be handed over for free to be published in closed access journals which, in turn, will charge huge amounts of money to public institutions for them to access the research they ultimately produced in the first place, or which will provide Open Access by also charging authors or institutions huge amounts of money while failing to create effective countermeasures for double dipping. Intellectual property of publicly funded research should be cherished and valued and not be given away for free in such a manner, which creates most of the imbalances and inequalities of the current academic publishing system. Commercial publishers, if handed for free the publicly funded scientific information they wish to publish, should have certain duties or obligations to respond to. One of them would be to allow the author's final version of the publication to be deposited and made available in Open Access in a public repository, at no extra charge and with no embargo delay whatsoever to the publications content, so that anyone with an internet connection could access and reuse the publication. This provision would put into the publishers' hands the decision and responsibility whether or not they wished to*

abide by these rules and how the publishing system would be shaped, hopefully in a fairer way."

The activities of commercial publishers need to be aligned with governmental policy on Open Science, as any misalignment makes it hard to implement changes in the publishing system as a whole. For example, costs and conditions for Gold Open Access must be closely monitored, and any deal with large publishers needs to be transparent and to keep costs to researchers and research institutions to a minimum, while preserving quality and effectiveness in scientific publishing. To this end, it is essential that research institutions and government officials in charge of negotiations with publishers are aware of Open Science mandates and attempt to implement them in their future contracts. For instance, the MLE delegate from Portugal noted that: "*We are currently having the experience of involving the university rectors' representatives in the negotiation processes for the next contract phase of the academic publications subscriptions, engaging them with the Open Science questions, and we notice much more awareness, much more understanding of the motives behind the Open Science agenda, and more will to change the current state of things and to back up any initiative in this subject*."

5.6 Valorising research in languages other than English

Many MLE participants noted the potential usefulness of Open Science initiatives in bringing visibility to research carried out in languages other than English. Indexes such as the Web of Science provide an incomplete and unreliable overview of international research outputs – especially in the field of social sciences and humanities, and are language biased because they mainly measure English-language publications. For example, national Open Access and Open Data repositories that are indexed in the English language can signal the presence of relevant research in other languages to scientist looking for existing knowledge on specific locations or issues. Thus, Open Science can make research available to a much larger pool of reviewers, thereby maximising the chance of critical interactions and cooperative improvement in the quality of research outputs. To achieve these goals, however, the needs and circumstances of researchers who do not write in English must be taken into account when developing Open Science infrastructure. It is also important to consider the cultural and political concerns relating to international discussions on national research outputs.

5.7 Optimising and rewarding human resource practices for research jobs across Europe

A key issue in providing adequate rewards, incentives and support (both technical and administrative) to the implementation of Open Science concerns the ways research-facing personnel are selected, managed and assessed. Human resource regulations and exemplary practices play a central role in enacting Open Science policies within research institutions, and providing a reference point for establishing goals and procedures for hiring, job descriptions and staff management. Existing initiatives for best practice in human resources are key to making Open Science a reality. One particularly useful initiative is the Human Resources Strategy for Researchers (HRS4R) Award (https://euraxess.ec.europa.eu/jobs/hrs4r), since most European research institutions are already signatories of the declaration, so there is an institutional commitment to abide by Open Science policy. The strong framework imposed by EU funding initiatives also provides a powerful incentive. Abiding by the HRS4R award, in parallel with the broader ERA roadmap, can provide an overview of what can be changed within institutions and how this fits the European framework. It is imperative that Open Science efforts, as identified for instance by the National Open Science Roadmap discussed below, are fully integrated into these broader developments and policy discussions.

5.8 Enhancing information and training tools

MLE participants stressed the significance of providing effective training and clear communications around what Open Science is, how it can be implemented, and what

advantages it has for researchers, policymakers, research institutions and civil society as a whole. Each member state needs to develop adequate sources of information and training programmes, building on existing resources (such as OpenAIRE and the Open Science Monitor maintained by the European Commission).

Participants also noted that the EU Communication on Open Science is currently too complex and confusing, even contradictory at times (for example, recent copyright law fostered in the Digital Single Market Directive was discussed as potentially at odds with Open Science policies). The available websites are not clearly structured and more work could be done to point out the practical implications of European Open Science policies, following up on several excellent initiatives undertaken by the Commission over the last five years to provide relevant knowledge and tools. One example is the EOSC web page which participants considered to be badly structured and difficult to decipher. This is problematic, particularly since many member states are looking to the Commission for guidance on Open Science infrastructure, and are deciding on their level of support for the EOSC.

5.9 Monitoring the transition to Open Science and its implications

A clear lesson learnt from ongoing initiatives in Open Science implementation across member states is the importance of monitoring the transition and its implications, and the challenges involved in such monitoring exercises. Keeping a finger on the pulse of ongoing Open Science initiatives, for instance, by assessing how they are being received by researchers of differing seniority, facilitates the choice and calibration of incentives and rewards, funding strategies and implementation of the next steps in the process. Many MLE participants also highlighted the importance of finding ways to embrace Open Science while retaining international visibility and status (for example, by avoiding slipping down the research rankings – which is a difficult proposition as long as those rankings are influenced by journal-impact factors and citation measurements based on incomplete indexing exercises). Research institutions have strong incentives to limit the investment in Open Science infrastructure and training, and national governments need to facilitate a shift in evaluation and investment cultures by strongly endorsing Open Science mandates and facilitating dialogue over the challenges and obstacles encountered by research stakeholders in implementing them.

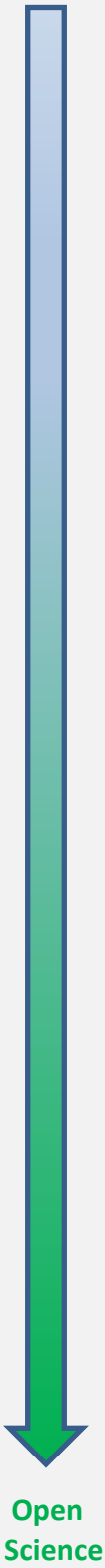
Building on the insights and experiences detailed above, as well as the goals and principles discussed in section 3, the next section draws up a national roadmap containing key stages of Open Science implementation, related timelines and the stakeholders involved.

6 NATIONAL OPEN SCIENCE ROADMAP: PRACTICAL STEPS TOWARDS OPEN SCIENCE IMPLEMENTATION AT NATIONAL LEVEL

This section proposes an indicative roadmap for the implementation of Open Science at the national level, comprising a list of stages involved in this process, examples of relevant activities for each stage, and a tentative time plan for achieving each stage. This *National Open Science Roadmap*, which is detailed in Table 1, follows the general rationale for Open Science implementation provided in the EU Report on Open Science Rewards (EU Working Group on Open Science Rewards 2017). This involves: (1) the removal of barriers through targeted investment and debate; (2) the provision of practical support and information on Open Science initiatives; (3) the provision of incentives to broaden Open Science adoption among stakeholders; and (4) the enforcement of Open Science practices in research evaluation procedures.

Table 1 provides a synoptic view of the various stages for implementing Open Science in member states. Given the large diversity in the stages within which each country finds itself, and the specific institutional and regulatory set-up within each nation, the examples provided as possible activities for each stage are only indicative. Each country will need to devise its own Open Science strategy, tailoring these suggestions to its specific situation. Note also that the time plan for implementing these stages will depend largely on each country's specific situation; therefore, the following should be seen only as a proposal around which to conduct discussions. It is perfectly possible to envisage these stages happening in a different order, or simultaneously, depending on the resources and priorities in each case. The intention is to provide a blueprint that could be used particularly by member states that are still at the beginning of their implementation of Open Science activities, to guide their discussions and stimulate the development of a national agenda (for countries where this has yet to be established) or monitor progress (for countries where Open Science is already being supported).

Table 1: National Open Science Roadmap for the implementation of Open Science at the national level, comprising a list of stages involved and examples of relevant activities for each stage



Stage	Target	Example of relevant activity
Map	Identify key stakeholders and Open Science champions	Launch mapping exercise to identify key stakeholders and potential contributors to Open Science activities Launch national consultation to capture ongoing Open Science activities and identify Open Science ambassadors and role models Organise Open Science round tables and venues for discussion
Plan	Devise national strategy through consultation with stakeholders	Produce a clear, widely available national agenda for Open Science Promote the agenda among relevant stakeholders and the general public, including through media campaigns Include Open Science discussion and monitoring in ERA roadmap meetings Ensure that the development and implementation of a national Open Science agenda is transparent, with easily accessible information sources that document the steps being taken
Incentivise	Change reward system to incentivise all aspects of Open Science, especially Open Data, Open Software, Open Education	Adopt OS-CAM Guide to research evaluation Establish funding-allocation system that rewards Open Science activities, such as Open Data, Open Education and public engagement Establish Open Science prizes and awards
Promote	Encourage critical and informed thinking around the implementation of Open Data	Require DMPs for all publicly funded projects Establish training in data ethics and data management for researchers, administrators and research institutions
Support	Participate in international initiatives to develop and maintain Open Science infrastructures	Identify and support key data repositories and data management tools (nationally and internationally) Contribute to the European Open Science Cloud and international publishing platforms
Implement	Implement strategy, starting from Open Access	Set up national repository for Open Access journals or preprints Devise and implement a legal framework which enables and supports Open Access publishing
Monitor	Monitor and tackle emerging issues as they arise, in consultation with stakeholders	Set up regular meetings among stakeholders to check on Open Science transition and outcomes Create monitoring systems for Open Science activities and track the availability of relevant tools and training in libraries, research institutions and funding agencies Establish clear points of contact and accountability for any emerging problems.

This National Open Science Roadmap must be considered in relation to the ERA roadmaps developed by every member state, and integrated into those very discussions to ensure coherence across government departments and international cooperation (and avoid duplication of efforts). Section 5b on 'Optimal circulation and transfer of scientific knowledge – Promoting Open Access' is of direct relevance here, although all other sections of the ERA roadmap are relevant to the implementation of Open Science in its comprehensive mode. The National Open Science Roadmap also builds on the much more detailed 'Roadmaps on Open Access and Open Research Data' developed by the League of European Research Universities (LERU) in 2011 and 2013 (LERU 2011, 2013). Finally, the National Open Science Roadmap builds on the set of incentives and rewards identified in the previous report, which are reported in Table 2.

Table 2: Synoptic view of the approaches to incentivising and rewarding Open Science activities discussed in the MLE Report on Incentives and Rewards for Open Science Activities

	OS-CAM research evaluation	OS training provision and education resources	Shifts in citation and authorship	Long-term sustainability	Open Science role models	Responsible innovation and public engagement	Transparency and accountability	International coordination and science diplomacy
Required conditions	Overhaul of evaluation procedures at research institutions and funding bodies	Resources and personnel to provide training locally and nationally	Overhaul of evaluation procedures and publishing formats	Complex coordination among stakeholders and long-term commitment	Establishing criteria for successful Open Science within each field; buy-in from learned societies and science academies	Rewards for social interaction and non-traditional outputs; co-design of research with relevant stakeholders	Systems for tracking, visualising and discussing the organisation, outputs and funding of research	Clear points of contact and communication channels/venues to debate Open Science implementation
Pros	Most important set of incentives and rewards for researchers	Enables researchers to practice Open Science effectively; produces innovative education tools	Recognition of currently invisible efforts to support Open Science	Crucial incentive for researchers; ensures the long-term fruitfulness of current investments	Exemplifying advantages of Open Science, and ways to successfully implement it; enhancing international status of research institutions; relatively inexpensive	Embedding of research in society, towards devising ethical and responsible solutions to global challenges.	Improved documentation and scrutiny of research processes and resources; better reproducibility of results and evaluation of accountabilities for given outcomes	Enhanced international visibility, networking and diplomatic relations across institutions and nation states
Cons	Time-intensive evaluation procedures	Investment in training provision and related staff; needs to be included in researchers'	Requires new policies tailored to each publication venue	Complex coordination among stakeholders and long-term financial support	Mobilising learned societies and science academies to actively promote Open	Risk of less investment in fundamental research; greater accountability for all research activities (including	Increased administration and more investment in data analysis and qualitative assessments	Increased national research budgets; need for coordination between science and foreign

	OS-CAM research evaluation	OS training provision and education resources	Shifts in citation and authorship	Long-term sustainability	Open Science role models	Responsible innovation and public engagement	Transparency and accountability	International coordination and science diplomacy
		workload			Science	privately funded ones)		policy
Challenges	Administrative, cultural and financial	Administrative, financial and cultural	Cultural and logistical	Logistical and financial	Logistical	Cultural, administrative, logistical, financial	Administrative, cultural, logistical	Administrative, logistical, political
Who implements this? (note: researchers are always involved)	Research institutions, funding bodies, researchers	Funding bodies, libraries	Research institutions, funding bodies, editors, publishers	EU, national governments, research institutions, libraries	National governments, funding bodies, learned societies	Funding bodies, research institutions, EU, national governments	Funding bodies, research institutions, EU, national government	National governments, policymakers, research managers.

7 CONCLUSION: NEXT STEPS FOR MEMBER STATES AND THE COMMISSION

The roadmap proposed in this paper must be discussed in detail by stakeholders in each member state, with **national governments** considering their response and strategies vis-à-vis European Open Science policies.

The establishment of systematic mapping exercises, detailing existing initiatives in each country and providing tools to take advantage of them at the international level, would be highly informative to future Open Science activities. As described in this report, there is considerable variation in the types of actors spearheading Open Science across the member states, and in the attitudes of research communities, institutions and public bodies towards engaging in Open Science. In some cases, efforts are championed by science academies (senior and/or junior); in others, by universities and/or funding bodies; and in others, by libraries and data infrastructure. It is imperative that member states develop mechanisms to identify and take advantage of existing strengths, as well as encouraging participation by the general public and stakeholders who have not yet engaged in Open Science.

Furthermore, the transition to Open Science needs to be closely monitored, paying attention to cost assessment and the evaluation of uptake, benefits and potential risks for each country and relevant stakeholders. The social and ethical implications of Open Science implementation must be discussed, scrutinised and tackled throughout the development of Open Science initiatives and related infrastructure and tools. Public engagement and the involvement of citizen science initiatives needs to be integrated into Open Science policy and actions, with extensive media campaigns targeted at enhancing the visibility of Open Science and promoting understanding of its significance and societal impact.

Discussion venues through which member states can regularly share insights, compare policies and experiences, and coordinate action are crucial. An example of such is the ERA Standing Group on Open Science and Innovation, whose existence, however, is not widely known and whose future existence and effectiveness currently depend on the efforts of individual participants. Such groups also provide a key platform for member states to discuss international initiatives, such as the EOSC, and to coordinate their contributions to the successful establishment and long-term maintenance of these international efforts.

The **European Commission** should take the feedback and experiences provided by member states into account when devising the next steps for the European Open Science policy and evaluating its effectiveness and potential. As also discussed in the 3rd MLE report, MLE participants consider the European Commission has a crucial role to play in guiding and coordinating the process of Open Science implementation. This is in view of the amount of expertise already accumulated by EU officials through the establishment of several expert groups and stakeholder consultation mechanisms around Open Science (such as, for instance, the Open Science Policy Platform), as well as tools for the provision of information, like the Open Science Monitor. In the words of one MLE participant: *"We believe the progress of EU member states in implementing Open Science shall be supported at the EU level, providing a basic source of information, pilot projects, best practices, role models as well as adequate guidelines and trainings to the policymakers are provided, to enable and support MS in making proper, EU harmonised steps in that direction."* In order to take advantage of the considerable work already carried out by the European Commission in gathering intelligence around Open Science implementation, it is essential that tools such as the Open Science Monitor and the various reports produced on aspects of Open Science are transformed into a service tool for policies and templates. Therefore, MLE participants call on the European Commission to continue its important role in fostering Open Science, for instance by:

- making Open Science provisions a key part of FP9;

- speaking with one voice across all directorates, for example by clarifying how intellectual property legislation intersects with Open Science provisions; and

- coordinating infrastructure provision, training and the development of common principles across directorates and with stakeholders (as in the current initiatives around the EOSC).

8 REFERENCES

Competitiveness Council 2015. *Council Conclusions on the ERA Roadmap 2015-2020*: https://era.gv.at/object/document/1817/attach/0_pdf.pdf (accessed 18 October 2017).

European and Global Young Academies (2016a). Position Statement on Open Data by the Young Academies of Europe and the Global Young Academy: https://globalyoungacademy.net/wp-content/uploads/2016/04/Position-Statement-on-Open-Data-by-the-Young-Academies-of-Europe-and-the-Global-Young-Academy.pdf (accessed 14 November 2017).

European and Global Young Academies (2016b). Position Statement on Open Access by the Young Academies of Europe and the Global Young Academy: https://globalyoungacademy.net/wp-content/uploads/2016/04/Position-statement-on-Open-Access-by-the-Young-Academies-of-Europe-and-the-Global-Young-Academy.pdf (accessed 14 November 2017).

EU Working Group on Open Science Rewards (2017). *Evaluation of Research Careers Fully Acknowledging Open Science Practices: Rewards, Incentives and/or Recognition for Researchers practicing Open Science*: https://ec.europa.eu/research/openscience/pdf/os_rewards_wgreport_final.pdf#view=fit&pagemode=none (accessed 12 October 2017).

Finnish Open Science Roadmap presentation (2017). https://openscience.fi/documents/10864/24849/Open+Science+and+Research+Initiative_2017.pptx/cd568751-650c-4251-983c-2e6d97829903 (accessed 17 November 2017).

Fyfe, A., Coate, K., Curry, S., Lawson, S., Moxham, N. and Mørk Røstvik, C. 2017. *Untangling Academic Publishing: A History of the Relationship Between Commercial Interests, Academic Prestige and the Circulation of Research*. Report: doi:https://doi.org/10.5281/zenodo.546100 (accessed 18 October 2017).

Holmberg, K. 2017a. *MLE on Open Science – Report on Different Types of Altmetrics*: https://rio.jrc.ec.europa.eu/sites/default/files/report/MLE%20Open%20Science_Report%20topic%201.pdf (accessed 11 November 2017).

Holmberg, K. 2017b. *MLE on Open Science - Report on Altmetrics and Rewards*: https://rio.jrc.ec.europa.eu/sites/default/files/report/MLE%20on%20Open%20Science_2nd%20Thematic%20report.pdf (accessed 11 November 2017).

Larivière, V., Haustein, S. and Mongeon, P. 2015. The Oligopoly of Academic Publishers in the Digital Era. *PLoS ONE* 10(6): e0127502.

Leonelli, S. 2017. *MLE on Open Science – Report: Incentives and Rewards to Engage in Open Science*: https://rio.jrc.ec.europa.eu/en/library/mutual-learning-exercise-open-science-%E2%80%93-altmetrics-and-rewards-incentives-and-rewards-engage

LERU Open Access Working Group, 2011. *LERU Roadmap Towards Open Access*: https://www.fosteropenscience.eu/sites/default/files/pdf/600.pdf (accessed 19 October 2017).

LERU Research Data Working Group, 2013. *LERU Roadmap for Research Data*: https://www.fosteropenscience.eu/sites/default/files/pdf/598.pdf (accessed 19 October 2017).

OECD, 2015. *Making Open Science a Reality – A Report*: http://wiki.lib.sun.ac.za/images/0/02/Open-science-oecd.pdf (accessed 11 October 2017).

9 APPENDIX

This appendix reports in full the answers given by MLE participants to the five questions posed in the section 'The Future of Open Science Implementation' in the questionnaire disseminated in summer 2017.

Question 1: Does your country have mechanisms to bring together policymakers, governmental agencies, funders, researchers and learned societies, research institutions, and libraries towards discussing science policy? What are they?

Such mechanisms are developed in implementing the Open Access policy in the country (the working group, consisting of the representatives of different stakeholders, nominated by the ministry). Would that be necessary to be established for the Open Science, we expect to follow a similar approach.
Switzerland: The SNSF is a private foundation and there are stakeholders from the ministry, research institutions, learned academies and other funding organisations represented in its top decision body, the Foundation Council. Furthermore, conferences and workshops are held by learned societies and other relevant actors that regularly bring together representatives of governmental bodies, funders and researchers at various career levels. See example below. http://www.snf.ch/en/theSNSF/organisation/foundation-council/ https://sciencesnaturelles.ch/wescientists
Belgium: Consultation among government offices (regional and federal) is officially conducted in the 'Conference for Federal Collaboration on Open Access' (CIS-CFS OA); all other stakeholders are welcome to join as 'experts'. At the federal level, a Repository Steering Committee composed of librarians, ICT and researchers discusses all OS issues.
Moldova: In as far as, at the moment, the Academy of Science is the leading institution in promoting the science policy, it is able, by its status, to bring together different bodies and institutions in policy discussions.
Yes, the coordination task will include all stakeholders.
Belgium: We have a concertation group at Belgian level which integrates civil servants as well as experts from academia and libraries. The aim is to discuss the BE positions on Open Science at a European level.
The implementation of the Open Access strategy is implemented under the leadership of a working group that includes different stakeholders. Additionally, there are also different workshops where different stakeholder work addresses the main challenges of implementing Open Access.
Portugal: Some of the Government's key principles for science policy are democratisation, appropriation of science by everyone and a better integration of science and society. Accordingly, it has been promoting public debate around science policy through a number of initiatives, such as public debate sessions in universities and research institutions with the presence of the Science Minister and the Science Secretary of State, as can be seen in this press release (only in PT): https://www.fct.pt/noticias/index.phtml.en?id=188&/2016/11/Sess%C3%B5es_de_Debate_P%C3%BAblico_sobre_o_Sistema_de_C&T,_o_Ensino_Superior_e_o_Emprego_Cient%C3%ADfico Another initiative resulting from FCT's response to Government priorities is the establishment of Thematic Agendas for Science and Innovation by FCT, where

researchers and other interested stakeholders in the research and innovation system in general are invited to participate in the definition of research agendas intended to meet specific societal needs and challenges. More info here (only in PT): https://www.fct.pt/agendastematicas/index.phtml.en A range of diverse stakeholders to discuss Open Science policy is also present at the WG-NOSP set up by the MCTES to help design a national Open Science policy, so please refer to the answer where the creation of the WG-NOSP is detailed.
Mechanisms do exist, but their usage and to what extent depends mostly on previously described challenges.
Partially, done at Government level.
Conference is a good platform for awareness raising on OS in academic society.
Austria: Open Access Network Austria: http://www.oana.at/en/home/ Austrian Library Consortium (KEMÖ): https://www.konsortien.at/ Austrian Platform for Research & Technology Policy Evaluation (fteval): http://www.fteval.at/en/platform/
No formal or official platforms exist, but informal exchanges between the main stakeholders take place.

Question 2: Do you have a 'model' for the implementation of Open Science, and if so, who was involved in creating it?

The 'model' (action plan) for the implementation of the Open Access is already developed for adoption. It will be soon used in practice. The full content of Open Science is not yet addressed with the present model.
Switzerland: https://www.swissuniversities.ch/fileadmin/swissuniversities/Dokumente/Hochschulpolitik/Open_Access/Open_Access_strategy_final_e.pdf
Belgium: Only for OA to publications. The pending mandate is not public. The Repository Steering Committee, under the presidency of BELSPO, drafted it.
Remove barriers (see above).
Unfortunately, no.
No.
Portugal: Please refer to the previously provided answers, especially the one where the creation of the WG-NOSP is detailed.
Currently there is no single 'model' for the implementation of Open Science. As described before (q. 17), there is a plan in place to develop such a model through the 'Science and Technology Foresight' project.
Moldova: Currently, the Academy of Sciences of Moldova is the lead on implementing Open Science.
No
No

Question 3: If you do not have a national approach to Open Science, why do you think this is the case?

A national approach to Open Science in its full dimensions is not yet developed. We believe the main reason is that the international processes and practices in Open Science are not yet "ripe" enough to make a clear enough picture of what exactly the adequate actions will be to make properly targeted policies, strategies and action plans to follow on a national scale. We believe the progress of EU member states in implementing Open Science shall be supported at the EU level, providing a basic source of information, pilot projects, best practices, role models as well as adequate guidelines and training for the policymakers to enable and support MS in making proper, EU-harmonised steps in that direction.
Belgium: The CIS-CFS has produced a national philosophy towards OA, soon to be extended to OD.
Sweden: We do have a national approach, please see the Research Bill (November 2016), only in Swedish though.
The focus is (too much) on Open Access to publications.
Switzerland: has a national strategy, however, this strategy is not based on a 'model approach' but rather on finding common interest and a 'common voice' while respecting its institutional diversity.
Croatia: The move towards "openness" in science gained momentum over the past few years. This is in part due to digital developments and new possibilities available in a data-driven economy, increased public engagement and transparency as well as the demand for synergies and the reduction of duplication of research. However, the trend still hasn't been acknowledged in the Croatian science and technology system to a greater extent. I believe that the difficulty lies in the fact that these, as well as some other policies, are perceived as separate policy streams. In a situation where there is very low investment in R&D, lack of consistency in policy implementation (due to unstable political situations) and many issues from previous periods that have to be addressed, it is difficult to work on system development and OS policy implementation as such. Only by integrating the OS policy into other policies is there a real possibility of it being implemented, as well as widely accepted.
Would benefit scientific community.
Discussions are not ripe yet. No 'champion' to lead the way!
Not applicable

Question 4: Can you discuss specific experiences or case studies from which you think something important about the implementation of Open Science can be learnt?

Slovenia: We see COBISS/SciMet (http://scimet.izum.si/) and personal bibliographies of researchers (http://home.izum.si/COBISS/bib/Help_SI_en.html) as a positive example. Researchers can (started in 2016) monitor the performance of their publications with the combination of Altmetric.com and PlumX. Even altmetrics are not yet taken formally into account in the evaluation of their research performance; they (as well as regulators and responsible institutions) can compare different altmetrics by providers, prepared in different ways and practice with this Open Science tool on its proper future formal implementation in evaluating researchers and research

performance in the country.
Belgium: Some institutions (Institute for Health Care Research, Belgian Nuclear Research Centre, Royal Library of Belgium) are setting up OA- and OD-compatible library systems. They consult BELSPO on this matter and share experiences and best practices.
No
Belgium: As explained above, the change of attitude of researchers from the University of Liège, once they realised that Green OA may help them to get more visibility (and citations). But this was the consequence of a tremendous effort of communication and awareness-raising from the OA team at the university (in particular, M. Thirion, director of the library).
Switzerland: The Swiss Centre for Expertise in the Social Sciences (FORS) provides a service for storing and using research data in the relevant disciplines in Switzerland. There is also the already mentioned 'scientific information' programme: https://www.swissuniversities.ch/en/organisation/projects-and-programmes/p-5/
The ones I am acquainted with are described in the 'ERAC Opinion on Open Research Data' and the OECD report 'Making Open Science a Reality - Final Report'.
Science Matters is a very good example for a bottom-up alternative to a 'classic' publication. https://www.sciencematters.io/why-matters. The Tamiflu scandal provides an interesting case in the life sciences domain. Tamiflu was developed by a pharmaceutical industry for the treatment of H1N1 virus. During the pandemic, many countries spent a considerable amount of resources stockpiling this drug. The Cochrane Collaboration obtained access to the clinical trial information (withheld by the company) and found out that the drug does not work so well after all. Letters exchanged with the company and the regulatory agencies as well as scientific results were finally published in different biomedical (Open Access) journals: British Journal of Medicine and PLOS Medicine: http://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1001201 http://www.bmj.com/content/345/bmj.e7689/rr/615611

Question 5: Can you point to problems or failures in implementing Open Science, from which useful lessons can be learnt?

There were few detailed answers to this question. One participant remarked: "I believe that the OS policy cannot be imposed but that it must be achieved through dialogue with the academic community." Another respondent pointed to answers to previous questions (see previous reports, Q 11).

The most extensive answer was provided by Portugal, as follows:

"The most important lessons learnt are that Open Science uptake needs a comprehensive approach addressing every aspect, from assessment to infrastructure to incentives, in order to be effective. If only some components of the system are addressed, any approach is very likely to fail. Honesty, transparency and making abundant information available to all stakeholders, particularly researchers, is crucial. The comprehensive approach must also extend to the range of stakeholders involved, with the engagement of all major research stakeholders. In particular, the full involvement of researchers right from the start of Open Science policy design and implementation is mandatory. In PT, we are currently having the experience of involving the university rectors' representatives in the negotiation processes for the next contract phase of the academic publications subscriptions, engaging them with the Open Science questions, and we notice much

more awareness, much more understanding of the motives behind the Open Science agenda, and more will to change the current state of things and to back up any initiative in this subject. But if this involvement and knowledge is not relayed to researchers; if they are not provided with the same degree of involvement, awareness and been given valid alternatives and adequate support – such as copyright retention provisions mandated by laws – to back their own Open Science decisions and deeds, the risk is that there may even be some backlash towards the Open Science agenda. I also don't think it is useful or realistic to go against the natural aspirations of researchers, of what drives them. One example is demanding the sharing of data that is destined to support a publication if such sharing could endanger the establishment of their scientific priority on the subject or if there are no adequate incentives for sharing such data, such as being given merit in the assessment procedures or when applying for funding. Of course, this all depends on the research area and type of communication that each discipline favours (and for some of them data itself is the main output of research to be communicated), but for a great deal of them it would be more realistic to demand the sharing of data at the moment of the first publication."

Getting in touch with the EU

IN PERSON
All over the European Union there are hundreds of Europe Direct Information Centres.
You can find the address of the centre nearest you at: http://europa.eu/contact

ON THE PHONE OR BY E-MAIL
Europe Direct is a service that answers your questions about the European Union.
You can contact this service
– by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
– at the following standard number: +32 22999696 or
– by electronic mail via: http://europa.eu/contact

Finding information about the EU

ONLINE
Information about the European Union in all the official languages of the EU is available on the Europa website at: http://europa.eu

EU PUBLICATIONS
You can download or order free and priced EU publications from EU Bookshop at: http://bookshop.europa.eu. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see http://europa.eu/contact)

EU LAW AND RELATED DOCUMENTS
For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex at: http://eur-lex.europa.eu

OPEN DATA FROM THE EU
The EU Open Data Portal (http://data.europa.eu/euodp/en/data) provides access to datasets from the EU. Data can be downloaded and reused for free, both for commercial and non-commercial purposes.

This report proposes a National Roadmap for the Implementation of Open Science, which lists the steps involved in transitioning to research governance that supports Open Science activities as part of national policy. The roadmap is based on a review of the current state of play in the development and implementation of national policies and related actions aimed at incentivising researchers and research institutions to engage with Open Science. The report starts by outlining key priorities and principles underpinning the implementation of Open Science at the national level in the future. It then reviews existing experiences in developing and supporting Open Science activities and related policies among those member states participating in the Mutual Learning Exercise. It concludes by summarising strategies, lessons learnt and models proposed to date, and proposing a roadmap for researchers, funders, research institutions and national governments that can help to guide Open Science implementation.

Studies and reports