

AURORA

Aurora Research & Innovation Open Science Knowledge Base

Deliverable 6.2



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Executive Summary

This report serves as an accompanying document to Aurora RI deliverable 6.2 - *A shared knowledge base of Open Science resources, policies and best practices*. It is the result of work carried out within the Aurora partner universities as part of the Horizon 2020-funded Aurora RI project.

Open Science represents an approach to the scientific process based on cooperative work and new ways of spreading knowledge by using digital technologies and novel collaborative tools. Open Science aims not only to make the primary outputs of research such as publications and the research data accessible in a digital format with no or minimal restriction, but also to extend the principles of openness to the whole research cycle, fostering sharing and collaboration as early as possible. It is particularly important when research has been publicly funded but should be considered by everyone involved in research. Therefore, Open Science involves a systemic change to the way science and research are done. It can be a critical accelerator for the achievement of the Sustainable Development Goals contributing in a decisive way to ensure inclusive and equitable quality education for all.

Based on our survey and discussions within our Work Package team, we have created a set of recommendations and actions. We recommend that Aurora universities:

- Signal their commitment to Open Science by incorporating its principles and practices in stimulating policies, implementation, dedicated funding and support.
- Embrace transparent research evaluation practices (e.g. [DORA](#), [CoARA](#)) and avoid inappropriate use of metrics to incentivize good research practices.
- Foster grass-roots Open Science communities to make transparency normative.
- Integrate Open Science skills development in the institutional strategies for professional competence development and lifelong learning
- Encourage the creation and usage of infrastructures to make the entire research cycle open and transparent, and research outputs interoperable and reusable. These infrastructures should be based on open-source software; widely used in international scientific communities; able to record persistent identifiers like ORCIDs, DOIs, NBNs, etc.; and be compliant with open standards and protocols.

In this report, we describe:

- ▲ Our definition of and requirements for Open Science
- ▲ Our methodology for collecting information
- ▲ Our recommended actions for Aurora universities

Project Abstract

Aurora was formed in 2016 as a consortium of research-intensive universities deeply committed to the social impact of their activities. The objective of Aurora is to match academic excellence with societal relevance. One of the core values of Aurora is to learn from and with each other and the Aurora RI project is an important part in realising this.

The Aurora RI project will develop closer research and innovation support structures to complement the excellent research and innovation activities within the Aurora Alliance, a European Universities Initiative funded by the European Commission. It will further deepen and expand the cooperation between these universities and strengthen their identities as research-intensive universities dedicated to societal impact. The aim of Aurora RI is to develop a research and innovation support agenda framed by the Sustainable Development Goals (SDGs) and based on the four priority domains of the Alliance:

1. Sustainability and Climate Change
2. Digital Society and Global Citizenship
3. Health and Wellbeing; and
4. Culture: Diversity and Identity.

The project focus is to identify and achieve an understanding of best practices and policies on sharing research infrastructure and resources, cooperation on open science and entrepreneurial activity, empowering human capital, and encouraging citizen engagement. Throughout the project we will analyse and map best practices already in place, learning from each other. We will define barriers to cooperation at national and international level and find ways to overcome them where possible. The findings will create the basis of our Research & Innovation support agenda and will be shared with other European Universities and beyond. The actions implemented during the project period aim to create a platform for cooperation that will continue beyond the lifetime of the project and will equip researchers and students at Aurora Alliance Universities with a broad toolkit for conducting excellent research and disruptive innovation.

Aurora RI Work Package 6: Open Science

Academia is in a transition towards a more transparent way of doing and sharing scientific research. This shift to Open Science increases the accessibility of research, which contributes to research integrity and opens new avenues for collaboration with other researchers and societal partners. In Work Package 6 of Aurora RI, we focus on *Sharing and implementing Open Science practices*. Within this Work Package, we have defined three tasks and four deliverables:

1. ***Building a shared knowledge base of Open Science resources, policies, and practices***

In this task, meta-information about research outputs, resources, policies, experiences, and practices on Open Science are collected from Aurora partners and beyond. The meta-information for Aurora partners is aggregated into an Open Science Monitor, and the best practices are collected in a knowledge base. This knowledge base allows the Aurora partners to learn from each other's choices and experiences. It is made freely available, so others beyond the Aurora Alliance may also benefit from it.

- ▲ *Deliverable 6.1 - Open science function to the SDG dashboard*
- ▲ *Deliverable 6.2 - A shared knowledge base of Open Science resources, policies, and best practices*

2. ***Establish a joint training programme on Open Science***

Building on the existing Aurora Open Education database and the knowledge base from Task 1, we establish Open Science training modules. These are aimed at helping students and researchers to incorporate Open Science practices into their research workflows and become ambassadors for Open Science. Topics that will be covered are Open Access publishing; how to make research data and software FAIR; how to guarantee research integrity; and how to engage with the general public about research. The educational resources for these training sessions will be made freely available.

- ▲ *Deliverable 6.3 - Open Science training modules*

3. ***Creation of a network of Open Science researcher communities within and between the Aurora institutions.***

A network of Open Science communities is created within and between the Aurora institutions. In these Open Science communities, students and researchers who want to learn about Open Science can share experiences and inspire each other. A platform will be created in which local communities within the Aurora Alliance institutions can interact with communities from other institutions, allowing for international collaboration.

- ▲ *Deliverable 6.4 - Open Science Community starter kit and a platform for these communities to interact*

Introduction

What is Open Science?

Open Science is a global movement that aims

- to “make scientific knowledge openly available, accessible and reusable for everyone,
- to increase scientific collaborations and sharing of information for the benefits of science and society,
- and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community”

as stated in the Recommendation on Open Science that was adopted by the 193 UNESCO Member states in 2021.¹

The Competitiveness Council of the EU adopted conclusions on ‘The transition towards an Open Science system’ and acknowledged that “Open Science has the potential to increase the quality, impact and benefits of science and to accelerate advancement of knowledge by making it more reliable, more efficient and accurate, better understandable by society and responsive to societal challenges, and has the potential to enable growth and innovation through reuse of scientific results by all stakeholders at all levels of society, and ultimately contribute to growth and competitiveness of Europe”.²

Requirements for Open Science

Open Science requires a new way of working, which is driven by funders, institutional and governmental policies, technology, and, importantly, by intrinsic motivation from many researchers, teachers, students and support staff themselves. To facilitate the transition to Open Science sketched in the vision above, an academic environment should be created that meets several requirements³:

- ▲ **Policy.** It is crucial that academic institutions signal their commitment to Open Science by incorporating its principles and practices (e.g. [DORA](#)) in stimulating policies, implementation, dedicated funding and support. It is essential to appreciate disciplinary differences and thus allow for different paces and priorities, while remaining adamant on the direction of change.
- ▲ **Recognition & Rewards.** In the current academic environment, practices reflecting the Open Science values—ranging from sharing results, altruistic cooperation, and engaging with stakeholders outside academic institutions—are not the norm, as they generally are not rewarded. To facilitate the transition to Open Science and, reward structures should change in such a way that its values and practices are better recognized and rewarded. To this end, concrete quantitative metrics for and qualitative evaluation of contributions (scientific output, as well as activities like leadership, mentoring, reflection and teamwork) to Open Science values and practices need to be developed.
- ▲ **Community Engagement.** To transition towards an open academic culture, it is important to create awareness of the Open Science principles and practices by facilitating a lively Open Science Community of academics and support staff. Within local Open Science Communities, members can learn from each other’s experiences and share their good practices for Open Science during events, workshops and

¹ UNESCO Recommendation on Open Science (2021):

<https://unesdoc.unesco.org/ark:/48223/pf0000381148/PDF/381148eng.pdf> II.6 (on p.6 of the English language version)

² Council conclusions on “Research assessment and

implementation of Open Science”(2022): <https://www.consilium.europa.eu/media/56958/st10126-en22.pdf>

³ These requirement are based on the Center for Open Science Strategy for Culture Change:

<https://www.cos.io/blog/strategy-for-culture-change>

regular meetings. Next to this, engagement with society must be encouraged in order to provide for open, inclusive, and participatory processes for knowledge creation.

- ▲ **Support & Training.** Researchers, teachers, and students need to be provided with the necessary skills and competencies for engaging in Open Science. This requires upskilling of current scientific, support, and teaching staff and the emergence of new professional roles like data stewards and research software engineers. Furthermore, the training capacity and training materials on relevant topics should be increased.
- ▲ **Infrastructure.** It should be possible for researchers and teachers to make their research and educational materials open and FAIR (Findable, Accessible, Interoperable, and Reusable). This requires technical and organisational infrastructure, which must be implemented in collaboration with other universities and (inter)national partners. This infrastructure should facilitate the standardisation of workflows, the creation of metadata and the interoperability of research objects within and across disciplines, allowing geographically dispersed groups of people to collaborate across institutional and academic boundaries.
In designing, implementing and connecting research and education infrastructure, it is crucial to consider its governance and provenance and retain (or retrieve) digital sovereignty through the adherence to guiding principles and supportive legislation and regulations at national and/or European level (e.g. on copyright retention and open licensing).

Aurora and Open Science

Within the Aurora institutions, there is a lot of momentum for Open Science. We set out to create a collection of the current Open Science policies, tools, solutions and practices as a valuable resource for all Aurora partners and beyond. To this end, we sent out a survey (see [Annex 1](#)) to all Aurora universities with questions on their activities on Open Science. We have added the responses to this survey in an accompanying document.

To structure this Aurora Open Science Knowledge Base, we used the five requirements for Open Science described above. From the responses and discussions within the Work Package team, we extracted recommendations and concrete actions.

Recommended actions

We encourage member universities to take a number of actions, along the lines of the five requirements.

Policies

Each university is at a different stage in the adoption of Open Science. The following observations and recommendations should be viewed in light of the local circumstances and existing provisions; some may use them to build statutes, policies, and guidelines, others may use them to check their level of progress and evaluate potential improvements or implementations.

The main goal is for the Aurora Universities to have a common Open Science strategy and policy, as advocated by the European Commission, and as recommended by the European University Association and research funding bodies.

Actions

- ▲ **Build consensus.** To prepare the ground and build consensus concerning Open Science, it is important to gain buy-in to the principles of Open Science from university leaders and other key stakeholders. It is also necessary to identify

individuals within the institution who can act as ambassadors and advocate for the relevance of engaging with Open Science.

To leverage a broad consensus for promoting Open Science, must be built through a two-pronged strategy, with top-level support from university governance and leadership on the one hand and from members of the various scientific communities on the other.

Depending on the size and the internal structure of the university, the approach might be to set up a single working group or to have multiple groups which are strongly coordinated with each other to ensure that the requirements of different scientific disciplines and fields of research are considered.

In this step, it is essential to involve:

1. The university's governance and leadership,
2. The university's IT department, responsible for setting up and running the technical infrastructure,
3. The university's library and other responsible units (such as university research offices) that administer the Current Research Information System (CRIS), repositories or other systems holding information about the university's research outputs with standardised metadata, persistent identifiers (ORCID, ROR, DOI, Handle, NBN, etc.).
4. The scientific community, in its broadest sense: faculty members, researchers at all career stages (from early career to senior) and across the range of disciplines, Ph.D. students, technicians, administrators, etc.

Each Aurora university should organise a public event, sponsored by the groups identified in Step 1.1, to spread awareness of the benefits to the scientific community of adopting Open Science policies. Other Aurora member universities should also be invited to this event to facilitate the sharing of experiences within the alliance.

- ▲ **Include Open Science in university statutes.** As advocated by the European Commission and the European University Association, each Aurora university should mention Open Science among the Principles in its Bylaws or General Regulations. In many countries, the Rectors' Conferences invited the universities to mention the principles of Open Science in their Statutes, to make the whole research cycle transparent, accessible, and reusable. Where such a reference to Open Science is (totally or partially) lacking, each Aurora university should integrate it internally, considering the work done by the groups formed during consensus building.

- ▲ **Create specific policies that support Open Science.** Aurora universities should develop policies and guidelines to promote open access and re-use of research outcomes.

More precisely:

1. Publications (articles, books, etc): Each Aurora university should have a policy regarding the free online dissemination of its researchers' scientific publications, requiring articles and books published by commercial and scholarly publishers to be deposited in its institutional, discipline-specific or other trusted open repository, preferably under an open licence. If the publisher does not permit the deposit of the version of record, the policy should make provision around the deposit of the pre-print or post-print.
2. Doctoral dissertations: Doctoral theses most often represent a researcher's first product of original research conducted at the university. Over the last fifteen years, many universities in Europe and around the world have adopted policies to encourage their free dissemination. Each Aurora university should have a policy for making theses and dissertations open access.
3. Research data: Each Aurora university should adopt a policy for making research data available according to the FAIR (Findable, Accessible,

Interoperable, and Reusable) principles. Guidelines for a Data Management Plan should also be made available.

4. Educational resources (Learning objects): Each Aurora university should have a policy for releasing Educational Resources into the public domain under an open licence that permits no-cost access, (re-)use, adaptation, and redistribution by others with no or limited restrictions.
5. Long-term preservation of publications, data, educational resources, and digitised documents: Aurora members should develop strategies and adopt policies and guidelines for the long-term preservation of research outcomes and other resources, to ensure that the scientific and scholarly knowledge produced in universities is passed onto future generations.

Recognition & Rewards

In the current academic environment, practices reflecting the Open Science values - ranging from sharing results, altruistic cooperation, and engaging with stakeholders outside academic institutions - are not the norm, as they generally are not rewarded. To facilitate the transition to Open Science and, reward structures should change in such a way that its values and practices are better recognized and rewarded. To this end, concrete quantitative metrics for and qualitative evaluation of contributions (scientific output, as well as activities like leadership, mentoring, reflection and teamwork) to Open Science values and practices need to be developed.

Actions

Within the Coalition on Advancing Research Assessment ([CoARA](#)), there is growing momentum for a transformation in the system of academic recognition & rewards.

As all Aurora partners, as well as the consortium itself, are signatories, we recommend Aurora universities to collaboratively work on joint action plans to implement the 10 commitments for signatories of CoARA:

- ▲ **Recognise the diversity of contributions to, and careers in, research** in accordance with the needs and nature of the research
- ▲ **Base research assessment primarily on qualitative evaluation** for which peer review is central, supported by responsible use of quantitative indicators
- ▲ **Abandon inappropriate uses in research assessment of journal- and publication-based metrics**, in particular inappropriate uses of Journal Impact Factor (JIF) and h-index
- ▲ **Avoid the use of rankings of research organisations** in research assessment
- ▲ **Commit resources to reforming research assessment** as is needed to achieve the organisational changes committed to
- ▲ **Review and develop research assessment criteria, tools and processes**
- ▲ **Raise awareness of research assessment reform** and provide transparent communication, guidance, and training on assessment criteria and processes as well as their use
- ▲ **Exchange practices and experiences to enable mutual learning** within and beyond the Coalition
- ▲ **Communicate progress made** on adherence to the Principles and implementation of the Commitments
- ▲ **Evaluate practices, criteria and tools based on solid evidence** and the state-of-the-art in research on research, and make data openly available for evidence gathering and research

For the transition towards Open Science, specifically Commitment 1 is of interest, as the recognition of the diversity of academic contribution includes “practices that contribute to

robustness, openness, transparency, and the inclusiveness of research and the research process including: peer review, teamwork and collaboration.”⁴

Community Engagement

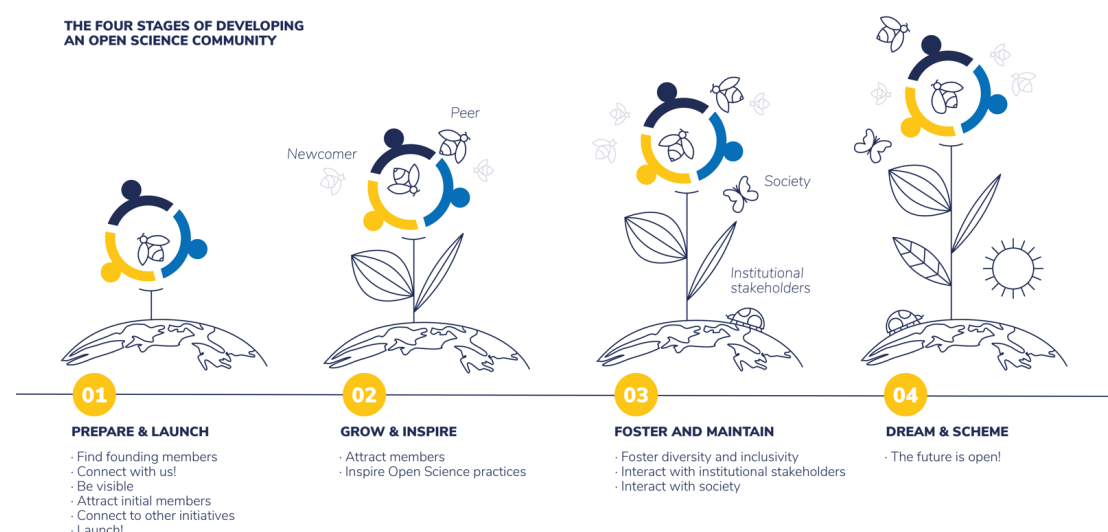
To transition towards an open academic culture, it is important to create awareness of the Open Science principles and practices by facilitating a lively Open Science Community of academics, students and support staff. Within local Open Science Communities, members can learn from each other’s experiences and share good practice for Open Science through events, workshops, regular meetings, and online discussion groups and forums. Alongside this, engagement with society must be encouraged to provide open, inclusive, and participatory processes for knowledge creation.

Building an Open Science Community is a challenging task. As the transition to Open Science practices is now a widely-accepted approach and required by all major funding providers, the increased engagement of academics, researchers and students needs to be planned and fostered to maintain a healthy, growing community willing to share knowledge and best practices, and in general to be active among its members.

We will build on the excellent INOSC Starter Kit⁵ and present some practical steps to build such a community.

Actions

We recommend each Aurora university to start and foster their bottom-up communities of Open Science enthusiasts. There are four stages of developing an Open Science Community:



Stages of developing an Open Science Community. INOSC Starter Kit CC BY-NC-SA 4.0

▲ Prepare & Launch

Identify founding members

A community coordinator will initiate the process. This must be someone willing to undergo the whole process of preparing, planning and coordinating activities, and engaging the members and the core team. This is a very time-consuming and demanding job which cannot be realised as a side activity.

⁴ Agreement on Advancing Research Assessment (2022):

https://coara.eu/app/uploads/2022/09/2022_07_19_rra_agreement_final.pdf

⁵ INOSC Starter Kit. <https://www.startyourosc.com/>

The community coordinator should be supported by a core team. This should be a mixture of enthusiastic support professionals and researchers who are passionate about Open Science, with team spirit and ability to inspire other people. Where possible, other institutional stakeholders like senior management, deans, various R&D officers, library, grant offices, academics, societies etc. should be involved with the core team.

Connect with the International Network of Open Science/Scholarship Communities (INOSC)

While we recommend undertaking the INOSC Incubator Programme, it is more important to connect the network to make it grow and to be able to learn from each other as there are already [many Open Science Communities \(OSC\) around the globe](#).

Attract initial members

The core team needs to identify suitable people to act as initial members of the OSC. They should be from the various units of the institution and - just like the core members - enthusiastic, innovative and curious about Open Science. Existing Open Science knowledge is most welcome but not required; the focus at the early stage should be Open Science training itself.

Connect to other OS initiatives at the institution

If there are any similar initiatives (like local faculty groups within a specific research field, students clubs, librarians, award offices etc.) then it would be a great boost at the start to engage them to be the first active members of OSC.

Launch

The official start of such OSC is an important step to let the wider institution know that the community exists. The kick-off event should introduce the community, share its vision, missions and plans and talk about the importance and advantages of building an OSC (with the participation of founding members). A convenient way to realise this kind of introduction is to connect it with other important events held at the institutions (for example festivals, open days and outreach days).

Grow & Inspire

Attract members

There are many ways in which the core team can build the member base of the OSC, but the most important is to offer activities and opportunities that will attract new potential members and encourage people to get involved, participate and stay connected.

Platform & Infrastructure - the way that the OSC members are connected (eg website, newsletter, online communication tools, regular meetings).

Events - these will need to be tailored to the level of maturity of the OSC, as some will require a certain level of experience, but it is important that some are conducted soon after the community launch in order to maintain momentum generated by the launch event. Examples of early events are training, lectures, discussion groups, and more informal, social meetings. The advanced types of events include one-to-one consultations, podcasts, sharing of failed practices, and gamification of the OSC (like achievements, badges, awards, etc.).

Training - a vital type of event in order to provide incremental increase in knowledge of OS, identify the target groups and their needs, and systematically offer a range of training opportunities from the basics to advanced and to cover whole areas where

Open Science is relevant (eg Open Access, Research Data Management, FAIRification, Data Management Planning, Legal Issues like GDPR and IPR, Commercialization, Research Ethic & Integrity). For the later stages of the OSC development there should also be training on advanced techniques which may be targeted at different research disciplines, or related to particular research methods..

Inspire Open Science Practices

OSC members should be encouraged to share their own experiences, practices, and workflows. Such events and meetings do not always require the most experienced members to be involved, and this can be a benefit if it encourages an honest and open environment where people feel comfortable in discussing difficulties and failures, and junior researchers and students can share their own successful workflows to inspire others. There are many different formats that could be encouraged by the community core team and that provide opportunities to create activities such as talks, workshops, study groups, journal clubs, webinars, and other member initiatives.

	Lightning talk	Workshop	Study Groups
Goal	Inspire	Engage	Commit
Audience	Open	Interested	Invested
Speaker	Beginner	Expert	Expert

Overview of event formats with matching levels of OS engagement. INOSC Starter Kit , CC BY-NC-SA 4.0

▲ Foster and Sustain

Most Open Science Communities are not yet sufficiently mature to have reached this stage in their development, so our recommendations are based on INOSC guidelines.

Diversity and inclusivity

Diversity, equity and inclusivity are core values of the Aurora consortium. The Open Science Community needs to analyze the diversity of the members to find out the right proportions between newcomers and the “veterans”, both to Open Science in general and to the OSC in particular. It should monitor that the member base represents the whole institution across all faculties and units, including students, academic staff, and support staff, and it should adopt the approach to not leave any part of the institution out.

Interactions between academia and society

An OS community should also include the non-scientific public in some of their activities and discussions, for instance on how to make science available to all. This involvement can be a valuable form of feedback for researchers and teachers within the community⁶ and increase the impact of Open Science. Within the Aurora universities, good practices for engaging with societal partners are shared through the work of Aurora RI Work Package 7.

⁶ INOSC Starter Kit.

<https://www.startyourosc.com/docs/chapter2/#3c-interactions-between-academia-and-society>

Institutional stakeholders: policy, infrastructure, and support

The right form of partnership with the institutional stakeholders like the management, policymakers, and other non-academic professionals can create greater mutual benefits. Stakeholders have different ways to reach certain target groups and the community gains the support and acknowledgement of its activities.

Stakeholder	Give	Take
Newcomers	Feedback on bottlenecks and boundary conditions	Learn Open Science skills, shape policy and infrastructure (influence)
Experienced colleagues	Share experience	Being able to inspire others (influence), platform to start initiatives (leadership), consolidate Open Science skills (sense of belonging)
Makers of policy and infrastructure	Being open to input (influence)	Well-tested ideas and experiences that help to re-shape or transform ways of working and institutional cultures
Librarians and support staff	Open Science training	Reach an audience interested in Open Science

The give and take of target audiences and stakeholders. INOSC Starter Kit  CC BY-NC-SA 4.0

Funding

Although participation in the OSC is voluntary and should be based on the need and desire to share experience and knowledge, the fundamental funding should be provided by the institution to secure support for the activities and to systematically engage non-academic professionals and students in such activities. There should also be the role of funded faculty ambassadors as critical connectors between the active OS community and the rest of the institution, especially active researchers. The budget for ongoing activities should also include provision for professional trainers from outside and inside the organisation.

Further community building

The most critical issue for the further growth of the OSC is to learn why more people should join the community and why they should stay in it. The essential reasons are to *upskill* (learn something new or improve the existing skills), *network* (to meet new people and maintain contacts), *co-create content* (be willing to share), and *gain support* (brainstorm, troubleshoot, get inspired). The community must provide support and an environment to meet those needs.

Assessment and monitoring

To be able to measure how successful the OSC is, it is necessary to assess the community over time. There are various proxies for doing this:

Number and characteristics of the members - how are the members distributed among the faculties and units? What is the ratio between OS “veterans” and those new to OS practices? What is the structure of the members (students, Ph.D. candidates, professors, professional staff, etc.)?

Number and type of community interactions - what are the numbers of participants in the community events and activities? Are the newcomers active in such events? How many are active in surveys and internal community discussions? What is the trend in recruiting new members? And many other measurable ways to monitor and assess the community's growth and maintenance.

Number and type of interactions with other stakeholders - Stakeholders may be institutional ones (e.g. in cooperation on the preparation of new regulations and methodologies, participating in more general institutional events and activities, involvement in realised projects, etc.) and also in (inter)national ones (participation on surveys and interviews, on institutional assessment, on international coalitions, etc.)

- ▲ **Dream and Scheme.** The final step is to prepare for the question - what's next? As the title of this stage suggests, future plans should be ambitious but with a clear vision for how these ambitions can be achieved. This stage is all about planning and finding the right way to shape the community and to consider where to focus its great potential with its critical mass.

Is academia already saturated with common OS knowledge? Is the community living its own, organic life without needing centralised coordination? Are there new barriers/issues that have arisen over time and need to be dealt with? Only time will tell.

Support & Training

Researchers, teachers, support staff, and students at the Aurora universities have to be provided with the necessary skills and competencies for engaging in Open Science (OS). Practising OS presupposes both specific skills relating to research infrastructures and technologies and more generic soft skills relating to collaboration and communication. This requires an institutional strategy for OS skills development, the upskilling of current scientific, support, and teaching staff, and the emergence of new professional support roles like data stewards and research software engineers.

OS skills development should be an element of an institutional strategy for life-long learning, continuing professional development, and skills development that is aimed at all internal stakeholder groups like students, researchers, and research support staff. An institutional strategy for OS skills development should be based on internationally recognised competence frameworks like the [FAIR Competence Framework for Higher Education \(FAIR4HE\)](#) or on formalised skills descriptions like the [Skills4EOSC Minimum Viable Skillsets](#) for different professional profiles. OS skills development should be addressed at the individual, the group, and the institutional level, because at its core OS is a collaborative undertaking and there are many different roles and responsibilities involved in OS practices. Within the Aurora consortium, practices on assessment and talent development are shared within Aurora RI Work Package 5.

OS skills development can be brought about through formal, non-formal, and informal learning. Formal learning comprises structured learning experiences that are planned and organised, such as training, workshops, seminars, or courses. They often have a set curriculum, clear learning objectives, and a specific outcome or certification. Formal learning can provide individuals with specialised knowledge and skills related to their profession. Non-formal learning refers to planned learning activities that occur through practical experiences and interactions. Examples of non-formal learning include on-the-job training, mentoring, self-directed learning, and networking. Non-formal learning can provide individuals with practical experience and a deeper understanding of their profession. Informal learning results from unplanned and unstructured learning activities related to work, family or leisure and is often unintentional from the learner's perspective.

The Aurora universities are encouraged to increase formal, non-formal, and informal learning opportunities in relation to OS. Local OS Communities as described in the preceding section

facilitate non-formal and informal learning processes by creating a space, where researchers, teachers, research support staff, and students can engage with OS topics. Formal learning processes are fostered in courses, workshops, or seminars. The Aurora universities are encouraged to increase their training capacity by collaborating on shared training resources and co-creating new training materials.

The broader dissemination and adoption of OS practices can be nurtured by creating new professional support roles like data stewards at the Aurora universities. This can be achieved by creating new positions and hiring data stewards with a relevant skills profile at the institutions. Alternatively, the institutions can assess the skill profiles of the existing support staff at the library, IT, and other units and upskill existing staff to offer data steward services. According to the first model, data stewardship services are provided by one or few professional experts, while the second model proposes to organise data stewardship services in professional teams.

Actions

The Aurora universities should:

- ▲ **Integrate Open Science skills development in their strategies for professional competence development** and lifelong learning for researchers, teachers, technical and administrative staff, and students.
- ▲ **Increase the training capacity and create new training materials** on Open Science topics in collaboration with other Aurora universities.
- ▲ **Increase support of Open Science practices**, either by creating new professional roles like data stewards or by upskilling existing technical and administrative staff.

Infrastructure

Technical infrastructures to support Open Science comprise a variety of platforms and tools, such as Current Research Information Systems (CRISs), repositories, data centres, electronic lab notebooks, e-learning platforms etc. Each university within the Aurora Network will make different choices over which to use, resulting from differences in when systems are adopted, differences in national (rather than institutional) infrastructure, and the needs of their particular research communities, for example. The presence of suitable infrastructures is crucial to enable Open Science, and infrastructures require flexibility to adapt to the changing requirements of the communities they serve.

Therefore, the following observations and recommendations should be viewed according to their local context: some may use them to build new infrastructures; others may use them to check their level of progress and evaluate potential improvements or implementations.

The main goal for Aurora members is to have a common vision, a shared knowledge and to transmit best practices in creating and/or using and/or improving infrastructures for Open Science.

The European Commission and the European University Association have repeatedly emphasised the importance of Open Science infrastructures that are compliant with major international standards for making data and metadata findable, accessible, interoperable, and reusable (FAIR). The European Commission has even directly funded the creation of Open Scholarly Communication Infrastructures, such as OpenAire and Zenodo.

In creating infrastructures, it is essential to involve:

- The university governance and leadership.
- The university's IT department, which will be responsible for setting up and running the technical infrastructure.

- The university's library and other responsible units (such as university research offices) that administer the Current Research Information System (CRIS) and repositories holding information about the university's research outputs with standardized metadata, persistent identifiers (ORCID, ROR, DOI, Handle, NBN, etc.).
- The scientific community, in its broadest sense: faculty members, researchers at all career stages and levels of seniority, Ph.D. students, technicians, administrators, etc.

Actions

- ▲ **Promote systemic actions for platform sharing** and good practices transferring in Aurora Network, to foster Open Science, and to contribute to Sustainable Development Goals (SDGs).
- ▲ **Encourage the creation of own and shared infrastructures** to make the whole research cycle open, transparent, interoperable, and reusable, and not only the end outcomes of scientific and scholarly research (i.e., articles and/or monographs).

Possible infrastructures include:

- Create institutional and/or disciplinary repositories to make the research outcomes published in subscription journals or books freely accessible by Open Access (according to the so-called Green route).
 - Implement their own or shared (among Aurora members) infrastructures for publishing journals, book series, and proceedings. If possible, it would also be highly advisable to create a university press with an imprint, to put the different publishing experiences into a system and ensure the scientific quality of publications, through editorial boards and peer review practices (including open peer review), in accord with the so-called open access Platinum route.
 - Create, share, or use freely available infrastructures (like OpenAIRE, Zenodo, etc.) to make research data open and FAIR (Findable, Accessible, Interoperable, Reusable).
 - Implement their own or use free available infrastructures for the Data Management Plan, to provide stable support to researchers in creating the Data Management Plan (also through common and shared initiatives in the Aurora network).
 - Establish or share with the other Aurora universities an infrastructure for Open Educational Resources, to make learning, teaching, and research materials in any format and medium freely available every time it is possible.
 - Create an infrastructure for academic blogs, to disseminate scientific knowledge among a non-academic audience, and foster active involvement of citizens in science wherever it is possible.
- ▲ **Promote Open Science infrastructures among students and staff**
 - In each department, organise presentations on the different infrastructures for researchers, administrative and technical staff, etc. Emphasise not only the benefits of the dissemination of one's publications but also the ethical relevance of choices that favours the achievement of the Sustainable Development Goals (SDGs).
 - Invite researchers to register at orcid.org to obtain a unique identifier as authors.
 - Sign an agreement with international and national non-profit organisations responsible for assigning DOIs to publications (CrossRef, etc.) and research data (DataCite), also together with other Aurora universities.
 - Sign agreements with national and international institutions and organisations involved in long-term digital preservation projects worldwide (national libraries, archives, international projects, etc.), to ensure the long-period conservation of scientific outcomes.
 - Support researchers in using and taking advantage of the existing infrastructures for their specific purposes.

- Each Aurora university should organise a public event to spread awareness of the benefits for the scientific community from using Open Science infrastructures. Other Aurora member universities should also be invited to this event to facilitate the exchange of experiences within the Alliance.

Annex 1: Survey

[University name]		
[Person in charge for updating data: Name Surname]		
1.	Statute of the University: Does it mention Open Science/Open access in its articles?	[Date and other details of its formal adoption, URL] / [Unavailable]
2.	Policy and guidelines: 1. Publications (articles, books) 2. Doctoral dissertations 3. Research data 4. Educational resources (Learning objects) 5. Digitized documents 6. Long-term preservation of publications, data, educational resources and digitized documents	[Date and other details about their formal adoption, URL, type of license adopted] / [Unavailable]
3.	Delegate and / or commission for Open Science	[URL, name of the delegate and / or name of the commission] / [Unavailable]
4.	University Press with Open Access Policy	[URL, name, activation date, number of open access publications] / [Unavailable]
5.	Rewarding for researchers to publish in Open Access	[details of the call / regulation / policy, URL, name, etc.] / [Unavailable]
6.	Institutional repositories for: 1. Scientific publications (Current research information system etc.) 2. Doctoral dissertations	[URL; used software; name; number of open access items] / [Unavailable]
7.	Disciplinary repositories for preprints, publications, data, etc., shared with other institution (other universities, research centers, scientific societies, etc.)	[nature of the archive / type of content, URL; software; name; number of open access deposits] / [Unavailable]
8.	Platforms for Working papers	[URL, name, activation date, number of open access publications] / [Unavailable]
9.	Platforms for the publication of open access scientific journals	[URL of OJS / basic URL of each journal managed with a different software; used software; available since... date; total number of open access articles published] / [Unavailable]

10.	Platforms for the publication of open access e-books series	[URL; used software; number of open access series and volumes] / [Unavailable]
11.	Repositories for research data and / or for Linked Open Data	[URL; used software; repository name] / [Unavailable]
12.	Platforms for Open educational resources	[URL, name, platform(s), initiatives] / [Unavailable]
13.	Open Access Platforms for popularization of scientific research	[URL, name, platform (s), initiatives] / [Unavailable]
14.	Open Access Platform for digitized historical documentation	[URL, name of the repository and, if different, original name of the digitized archive, software] / [Unavailable]
15.	Adopted strategies for long-term preservation of: 1. e-Journals and e-book series published by the University 2. Research data 3. Open educational resources; 4. Digitized historical documentation	[URL of the long-term storage platform(s); name, etc.] / [Unavailable]
16.	Open Science Training and Open Data Stewardship	[URL; name of the course etc.] [Beneficiaries (ERC winners, professors etc.), Periodicity; organizing structure(s)] / [Unavailable]
17.	Participation in national and international networks of universities that develop an Open Science program	[Name, date of application] / [Unavailable]
18.	Does the university follow precise procedures for monitoring the costs of: 1. Publication of articles and journals with commercial publishers 2. Publication of printed and/or electronic books and books series with commercial publishers 3. <i>Article Processing Charges</i> (APC) required by commercial publishers for having articles available in open access 4. Subscriptions of electronic resources	[Is the survey published in Open Access (in Open data?) or in restricted access? If openly available, please provide the URL] / [Unavailable]
19.	Other info	[For instance: Does the University publish an annual report on Open Science? Does the University/University Library make Open Science Data available on its website? If yes, please provide the URL] / [Unavailable]