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## D2.1 Targeted landscape analysis report

Joy Davidson, Sara Pittonet, Sandra Boerman, Loek Brinkman, Clement Jonquet, Vasso Kalaitzi, Xeni Kechagioglou, Herve l'Hours, Liisa Marjamaa-Mankinen, Benjamin Mathers, et al.

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## D2.1 Targeted landscape analysis report

Work Package	<b>WP 2 Engagement, Adoption &amp; Implementation</b>
Lead Author (Org)	<b>Joy Davidson (DCC), Sara Pittonet (Trust-IT)</b>
Contributing Author(s) (Org)	<b>Sandra Boerman (DeiC), Loek Brinkman (DANS), Clement Jonquet (INRAE), Vasso Kalaitzi (KNAW-DANS), Xeni Kechagioglou (LifeWatch ERIC), Herve L'Hours (UKDS), Liisa Marjamaa-Mankinen (CSC), Benjamin Mathers (UKDS), Rita Meneses (Trust-IT), Josefine Nordling (CSC), Ryan O'Connor (DCC), Alejandra Gonzalez-Beltran (UKRI-STFC)</b>
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## Executive summary

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FAIR-IMPACT aims to support the implementation phase of the European Open Science Cloud by helping Research Performing Organisations (RPOs), repositories and data and metadata service providers (including persistent identifier services and semantic services) and national level initiatives to adopt FAIR-enabling practices, tools and services. To this end, FAIR-IMPACT is conducting a targeted landscape analysis to identify viable tools, methods and solutions that have been produced by the recent H2020 INFRAEOSC FAIR-related projects and that are currently available to support FAIR Implementation in a practical sense. The resulting **FAIR Implementation Framework (FIF)** catalogue of resources will be made accessible via the FAIR-IMPACT website to enable others to find, assess and adopt them.

The FAIR implementation framework will be instrumental for delivery of in-kind support to RPOs, repositories and data service providers, and national level initiatives, but the framework will also be openly available to support adoption by a wider range of stakeholders across Europe and globally. The framework will be updated periodically to ensure that emerging approaches, tools and resources such as those resulting from ongoing related projects and initiatives are included.

This report outlines the approach adopted for the landscape analysis, a summary of the projects and initiatives reviewed, and next steps in developing the FAIR Implementation Framework.

## Terminology

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Terminology/Acronym	Description
EOSC	European Open Science Cloud
ESFRI	European Strategy Forum on Research Infrastructures
FAIR	Findable, Accessible, Interoperable and Reusable
FIF	FAIR Implementation Framework
INFRAEOSC	Term for the projects funded under Horizon 2020 and Horizon Europe to support the implementation of the European Open Science Cloud
RI	Research Infrastructure



# 1 Introduction

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## 1.1 Purpose of the targeted landscape analysis

FAIR-enabling services (i.e., those that support the creation, management, sharing and reuse of FAIR research outputs) will play a key role in the implementation of the European Open Science Cloud (EOSC). FAIR-IMPACT aims to increase the availability of such services by helping Research Performing Organisations (RPOs), repositories and wider data service providers and national level initiatives to adopt FAIR-enabling practices, tools and services. To this end, FAIR-IMPACT is conducting a targeted landscape assessment to identify viable tools, methods, guidance and exemplar solutions that have been produced by the recent H2020 INFRAEOSC FAIR-related projects and are currently available to support FAIR Implementation in a practical sense. This report outlines the approach taken to carry out the landscape assessment.

Based on the outcomes of the targeted landscape assessment, the FAIR-IMPACT project will develop the first iteration of the **FAIR Implementation Framework (FIF)** which will be released in May 2023. The framework will help different stakeholders assess their drivers for becoming more FAIR-enabling and their current practices so that they can develop realistic action plans to implement FAIR. The framework will include a catalogue of resources to help different stakeholders to navigate the range of resources available to help implement the FAIR principles. The catalogue will provide contextual information about the resources and, more crucially, provide advice and guidance on how and when these resources can be used most effectively. FAIR-IMPACT will use the FIF to help structure the support we provide to successful organisations applying to our open calls for support. As we develop the FIF, we will endeavour to avoid duplication of effort but rather to complement and link to resources that are described in existing registries such as FAIRsharing and the EOSC portal. FAIR-IMPACT will also provide a series of FAIR Implementation webinars between 2023 and 2025 which will help to promote the resources included in the FAIR Implementation Framework catalogue.

### 1.1.1 Scope and methodology

The initial landscape assessment has been targeted to identify relevant tools, methods and supporting resources produced by the tranche of **FAIR-related INFRAEOSC regional, thematic, horizontal and cluster projects supported under H2020** - many of which have been integrated into the FAIR-IMPACT project as use cases. The recently completed EOSC 5B regional and thematic projects aimed to support EOSC implementation in different EU countries while the ESFRI cluster projects worked to develop data management methodologies, services, and technical solutions in collaboration with European infrastructures. There are a number of other relevant FAIR initiatives that have produced tools, approaches and solutions including FAIRsharing and GO-FAIR (Figure 1 provides an overview of the EOSC landscape in H2020).

Figure 1. FAIR and EOSC Ecosystem in H2020



Over the life of the project, FAIR-IMPACT will monitor the landscape to identify additional tools, methods and resources emerging through the Horizon Europe INFRAEOSC projects.

Table 1. H2020 Cluster projects


<sup>1</sup> <https://sshopencloud.eu/>

<sup>2</sup> <https://www.panosc.eu/>






**Table 2. H2020 INFRAEOSC regional and thematic projects**


<sup>3</sup> <https://projectescape.eu/>

<sup>4</sup> <https://envri.eu/home-envri-fair/>

<sup>5</sup> <https://www.eosc-life.eu/>

<sup>6</sup> <https://ni4os.eu/>

<sup>7</sup> <https://www.eosc-pillar.eu/>

<sup>8</sup> <https://www.eosc-synergy.eu/>

<sup>9</sup> <https://www.eosc-nordic.eu/>

<sup>10</sup> <https://www.fairsfair.eu/>





**Table 3. Other FAIR Initiatives**


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<sup>11</sup> <https://expands.eu/>

<sup>12</sup> <https://fairsharing.org/>

<sup>13</sup> <https://fairplus-project.eu/>

<sup>14</sup> <https://www.go-fair.org/>



Desk research was undertaken in late 2022 to review and collate the outputs of the projects listed above for possible inclusion in the FAIR Implementation Framework. The team's desk research also included a review of the recently released *Delivering for EOSC: Key Exploitable Results of the Horizon 2020 EOSC-related projects*<sup>15</sup> report which summarises 119 resources that were produced. Finally, the information provided by participants of the first Synchronisation Force workshops<sup>16</sup> was reviewed to identify additional resources from a number of H2020 and Horizon Europe INFRAEOSC projects and relevant initiatives.

More than fifty potential resources have been identified during this initial landscape assessment (see Annex 1 for the list). This longer list will be refined during an internal review process in early 2023. The goal of further refining this collection is to identify those resources that address a particular need in a practical sense (e.g. tools or solutions that help perform, or provide the necessary information to perform, a specific FAIR enabling task or activity) rather than more general resources that are better suitable for awareness raising around FAIR. A key aim is to promote the adoption of the resources that have been created through INFRAEOSC support especially those that are not currently included in the EOSC Marketplace<sup>17</sup> or the EOSC Portal<sup>18</sup>, for delivery of in-kind support to research performing organisations (RPOs), repositories and data service providers, and national level initiatives. The process and criteria are described in section three of this report.

<sup>15</sup> Ilaria Nardello, Ari Asmi, René Buch, & Erik-Jan Bos. (2022). Delivering for EOSC - Key Exploitable Results of Horizon 2020 EOSC-related Projects (FULL Report). Zenodo. <https://doi.org/10.5281/zenodo.7401539>

<sup>16</sup>Synchronisation Force 1st Workshop - November 2022  
<https://fair-impact.eu/events/synchronisation-force-events/synchronisation-force-1st-workshop-november-2022> and collaborative spreadsheet  
<https://docs.google.com/spreadsheets/d/1CgJdkxPb1WxoWTsKMIIIIO5VOe7G4IMzkVPtzaC7IE/edit?usp=sharing>

<sup>17</sup> EOSC Marketplace <https://marketplace.eosc-portal.eu/services>

<sup>18</sup> EOSC Portal <https://search.eosc-portal.eu/search/all?q=FAIR>



## 2. Describing the resources

To ensure that the resources were described consistently during the desk research phase, a webform<sup>19</sup> was created to capture relevant information about the resources. A list of the fields included in the webform is provided below (see Table 4). A key aim was to identify the primary use case for each submitted resource, key actors who should make use of the resource, any skills or knowledge needed to make use of the resource, the current availability of the resource, and the availability of guidance to support its use.

The webform is open for anyone (upon registration) to submit candidate entries for the catalogue and will remain open until the end of the project, however the primary intention has been to use the form internally to support the desk research. The candidate resources will be reviewed by the project partners for inclusion in the first iteration of the FAIR Implementation Framework (FIF) to be released in May 2023 (see section 4 for details). A campaign to elicit suggestions from the community for additional resources to be considered for inclusion in future updates of the FIF will be launched following the release of the first iteration.

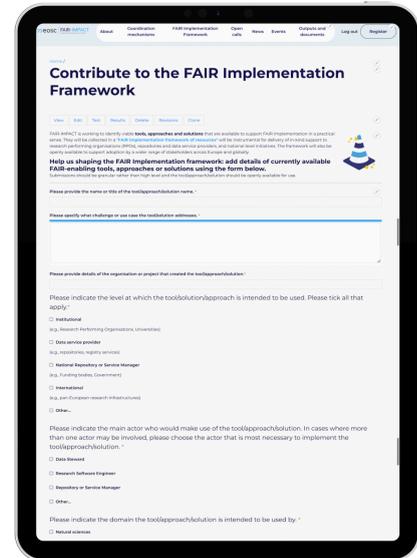


Image: FIF webform online

Table 4. Fields included in the webform to describe resources

Field	Input type

<sup>19</sup> FAIR-IMPACT website <https://fair-impact.eu/ImplementationFramework-inputform>



Field	Input type



Field	Input type

### 3. Periodic updates of the landscape

The targeted landscape assessment was realistic in scope and enabled FAIR-IMPACT to develop a consistent approach to describing useful tools, methods and approaches that are currently available for use/reuse. FAIR-IMPACT will review the landscape again in May 2024 and finally in May 2025 to ensure that emerging approaches, tools and resources such as those coming through the tranche of Horizon Europe INFRAEOSC projects are identified and included in the FAIR Implementation Framework and potentially offered as FAIR Implementation Webinars. Table 5 provides an indicative list of projects that will be reviewed during the updates.



Image: INFRAEOSC projects identified for being included in the FAIR Implementation Framework

Table 5. List of INFRAEOSC2021 projects to be monitored in periodic updates.


<sup>20</sup> EOSC Focus <https://eosc.eu/eosc-focus-project>

<sup>21</sup> FAIR-EASE <https://fairease.eu/>




<sup>22</sup> FAIRCORE4EOSC <https://faircore4eosc.eu/>

<sup>23</sup> BeYond COVID <https://by-covid.org/>

<sup>24</sup> EOSC4Cancer <https://eosc4cancer.eu/>

<sup>25</sup> Artificial Intelligence for the European Open Science Cloud (AI4EOSC) <https://ai4eosc.eu/>

<sup>26</sup> WorldFAIR <https://worldfair-project.eu/>






<sup>27</sup> RAISE <https://raise-science.eu/>

<sup>28</sup> EuroScienceGateway <https://galaxyproject.org/projects/esg/>

<sup>29</sup> WorkflowHub <https://workflowhub.eu/>

<sup>30</sup> Six new HE INFRAEOSC Projects

[https://eosc.eu/news/six-new-he-infraeosc-projects?utm\\_source=newsletter&utm\\_medium=email&utm\\_campaign=20230110\\_january](https://eosc.eu/news/six-new-he-infraeosc-projects?utm_source=newsletter&utm_medium=email&utm_campaign=20230110_january)




FAIR-IMPACT is making use of the Synchronisation Force<sup>31</sup>, our participation in EOSC-Association concertation events<sup>32</sup>, and the EOSC Forum<sup>33</sup> to monitor and engage with the range of current projects as well as new projects that are supported. In addition, the webform will remain open for the duration of the FAIR-IMPACT project to allow members of the community to suggest resources that they feel should be included in the FAIR Implementation Framework catalogue.

<sup>31</sup> FAIR-IMPACT Synchronisation Force <https://fair-impact.eu/synchronisation-force>

<sup>32</sup> The first EOSC Association concertation event was held in September 2022. <https://eosc-portal.eu/events/eosc-concertation-meeting>

<sup>33</sup> EOSC Forum <https://forum.eosc.eu/>



## 4. Next steps

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The resources identified during the targeted landscape assessment will be internally reviewed in early 2023 to determine whether they should be included in the first iteration of the FAIR Implementation Framework which will be released in May 2023. Members of the FAIR-IMPACT project will review the identified resources and ensure that they meet the criteria listed below for inclusion in the FAIR Implementation Framework. The criteria are intended to be inclusive and are similar to those employed by the EOSC portal<sup>34</sup>. Specifically, resources that will be included in the FAIR Implementation Framework should:

- address a granular FAIR use case (i.e., help a user to do something concrete)
- relate to one of FAIR-IMPACT's core thematic areas (persistent identifiers, metadata & ontologies, metrics & certification, and interoperability)
- be openly available now
- provide some kind of support - e.g., static guidance doc and/or on demand helpdesk
- be able to be used independently (i.e., without a need for additional support)

The refined list of resources that emerge through the internal review process will be presented via an online catalogue and will form part of the FAIR Implementation Framework which aims to help different stakeholders assess their drivers for becoming more FAIR-enabling and their current practices so that they can develop realistic action plans to implement FAIR. The catalogue will be built as a browsable online tool which users will use to identify the tools/solutions most appropriate for their case, with direct links to the original resources and to the EOSC portal whenever a resource is published there. For those resources that are not currently included in the EOSC portal, the FIF catalogue may help to highlight services that could be registered.

The FAIR Implementation Framework will be used to help design and deliver support for research performing organisations, repositories and data service providers, and national level initiatives that FAIR-IMPACT will engage with as part of our in-kind support programme which will be launched through an open call in August 2023. Successful applicants to the open call will receive dedicated support from FAIR-IMPACT to self-assess their current FAIR-enabling capacity using existing assessment frameworks such as ACME-FAIR<sup>35</sup> and F-UJI<sup>36</sup>, to co-develop FAIR implementation action plans, and to consider how they will secure the necessary engagement for implementation. The draft framework builds on the approach employed by ACME-FAIR which places equal emphasis on both building capabilities for enabling FAIR and also on active engagement to ensure uptake of FAIR-enabling practices. Table 6 provides an overview of the draft framework that is still in development.

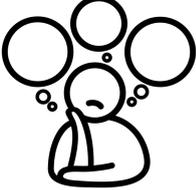
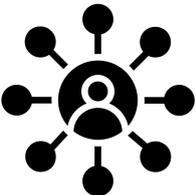
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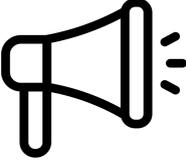
<sup>34</sup> EOSC Portal <https://providers.eosc-portal.eu/becomeAProvider>

<sup>35</sup> ACME-FAIR <https://www.fairsfair.eu/acme-fair-guide-rpo>

<sup>36</sup> F-UJI <https://www.fairsfair.eu/f-uj-automated-fair-data-assessment-tool>

**Table 6. Draft FAIR Implementation Framework to structure and guide the delivery of support to successful applicants to the in-kind support programme**

As shown in the table above, a number of templates, checklists, and guidance materials will be developed for each of the FIF components. This work will be carried out in the first half of 2023. We will share the drafts for wider comment through the FAIR-IMPACT website. We will seek input from colleagues in Horizon Europe (HE) INFRAEOSC projects through our participation in the EOSC Focus HE Communication & Engagement Working Group and the shared platform they provide<sup>37</sup>.

<sup>37</sup> EOSC forum <https://forum.eosc.eu/>



## Annex 1 - Condensed list of resources

The table below provides a list of the candidate resources identified during the targeted landscape assessment. Please note that this table has been condensed to show just the first three fields of the information collected for each resource due to space constraints. The full information for those resources that are selected for inclusion in the first iteration of the FAIR Implementation Framework will be released via the FAIR-IMPACT website at the end of May 2023. Please note that the list currently includes resources produced by the INFRAEOSC projects but also additional resources that have been suggested by consortium partners.

#	Organisation or project that created the tool approach/ solution.	Name or title of the tool/ approach/ solution.	Challenge or use case the tool/solution addresses.
1	CESSDA	Video: Make Your Research Data F.A.I.R	This video aimed to show how researchers can make their data Findable, Accessible, Interoperable, and Reusable; how to assess the FAIRness of research data; and which tools to use to make data more FAIR.
2	CESSDA	Guide: Preparing research data for open access: guide for data producers	Guide for data producers that cover the preparation of research data for open access. Prepared by: Arhiv družboslovnih podatkov (Social Science Data Archives) Language editing: Stuart Macdonald Book editing: Medium Žirovnica
3	CESSDA	Webinar: Access Policies and Usage Regulations: Licenses	Increase knowledge of licensing and why it is important that research data are provided with licenses. The webinar addresses the challenges and benefits of sharing research data, data ownership, reuse and types of licenses.
4	CESSDA	Video: CESSDA Series on Variable Harmonization: Process, Challenges and Quality Criteria	Increase knowledge of social science metadata and variable harmonization by presenting from large international survey programs. Topics covered include an introduction to social science variable harmonization, the use of international standard classifications and how to use metadata to construct FAIR variable harmonization documentation.

#	Organisation or project that created the tool approach/ solution.	Name or title of the tool/ approach/ solution.	Challenge or use case the tool/solution addresses.
5	CLARIAH	CMDI2RDF	CMD2RDF is a CLARIN-NL project to make CMD records (XML) available as RDF.
6	ENVRI FAIR	ENVRI FAIR Training Catalogue	The Training Catalogue was designed to facilitate findability, sharing and reuse of educational resources on FAIR data management. It hosts searchable metadata of educational resources (collected by ENVRI), including accessibility information.
7	ENVRI FAIR and GO FAIR	FAIR Implementation Profiles Wizard Tool	The FIP Wizard is a toolset that facilitates the capture of data in the FAIR Convergence Matrix questionnaire, declaring a FAIR Implementation Profile. It is used for the evaluation of the implementation status of FAIR data practices. These profiles can then be stored and published as nanopublications that help monitor progress at individual environmental RI or at any other community level.
8	EOSC Life	LS AAI Life Science login	The Life Science Log in enables researchers to use their home organization credentials or community or commercial identities (Orcid/Linkedin) to sign in and access data and services they need across multiple platforms.
9	EOSC Pillar	Federated FAIR Data Space (F2DS)	F2DS provides tools for both data producers and data consumers contributing to enhance the overall FAIRness of datasets natively dispersed across heterogeneous repositories by realising services for datasets homogenisation, enrichment and onboarding and services for seamless discovery and access. With a F2DS, researchers will be able to search, find and retrieve data using a single access point and tool set. Not only does this saves working time because it masks the various access methods of different sources and offers a single access point through user and programming interfaces (UI and API), but it can truly deliver new insights, given the proper combination of selected search criteria and content of one or more data-sets is



#	Organisation or project that created the tool approach/ solution.	Name or title of the tool/ approach/ solution.	Challenge or use case the tool/solution addresses.
			explored in unison. The F2DS is a unifying data space that is built by aggregating and enriching datasets from a set of multidisciplinary repositories, i.e. data sources, with the aim to facilitate data discovery and re-use. Although datasets are the primary focus of the resulting data space, other items are managed including repositories and data sources, APIs, metadata schemas and ontologies.
10	EOSC Synergy	FAIR Framework	The main component, known as FAIR EVA, checks FAIRness level of digital objects from different repositories or data portals. It requires the object identifier and the repository to check and it can be adapted to different contexts and environments. Facilitates data integration in repositories according to FAIR principles. It aims at helping data producers and data managers to evaluate the adoption of the FAIR principles based on the RDA indicators.
11	EOSC-Nordic	Recommendations for FAIR Evaluation Services	16 step guidance and recommended actions if F-UJI tests fail
12	ExPaNDS project	Ontologies to support FAIR data implementation in Photon and Neutron (PaN) data catalogues	Exploitation of FAIR principles (especially Findability) can be hampered by the lack of consistency in metadata used to annotate data records and search databases. Several small ontologies have been developed to facilitate consistent semantics for terms within the PaN domain by providing global persistent identifiers, community agreed labels and synonyms, and human-readable definitions, annotations and references. Crucially, each ontology is supported by a community maintenance process to allow a managed and agreed approach to modification and extensions in future development.
13	ExPaNDS project, with influence from PaNOSC	Data policy support for facilities science	Assists with the framing of data policies for research infrastructures, especially in the photon and neutron (PaN) domain. The framework proposes a set of 21 elements to consider when formulating data policy, and was developed in consultation with all ten PaN facilities in ExPaNDS. Although the framework was produced specifically in the

#	Organisation or project that created the tool approach/ solution.	Name or title of the tool/ approach/ solution.	Challenge or use case the tool/solution addresses.
			PaN context, it is sufficiently general that it is likely to be of value in other fields.
14	FAIR4Health	From Raw Data to FAIR Data: The FAIRification Workflow for Health Research	This scientific contribution addresses the architecture design of an open technological solution built upon the FAIRification process proposed by "GO FAIR" which addresses the identified gaps that such a process has when dealing with health datasets.
15	FAIR4Health	FAIR4Health Data Curation Tool	This is a standalone, desktop application developed by the FAIR4Health project ( <a href="https://www.fair4health.eu/">https://www.fair4health.eu/</a> ). The tool is used to connect the health data sources which can be in various formats (Excel files, CSV files, SQL databases) and migrate data into a HL7 FHIR Repository. The tool shows the available FHIR profiles to the user so that he/she can perform mappings appropriately. The tool can also contact a Terminology Server (which is actually another HL7 FHIR Repository) so that data fields can be annotated if coding schemes such as ICD10 or SNOMED-CT are in use.
16	FAIR4Health	FAIR4Health Data Privacy Tool	This is a standalone, desktop application developed by the FAIR4Health project ( <a href="https://www.fair4health.eu/">https://www.fair4health.eu/</a> ). The tool aims to handle the privacy challenges exposed by the sensitive health data. It is designed to work on an HL7 FHIR API so that it can be used on top of any standard FHIR Repository as a data de-identification, anonymization, and related actions toolset. The tool accesses FHIR resources, presents metadata to the user, guides the user about the configuration to be applied and then outputs the processed FHIR resources.
17	FAIR4Health	FAIR4Health Common Data Model	The Common Data Model of the FAIR4Health Project is implemented as HL7 FHIR profiles. This project includes the following in 2 main directories: - The FHIR Implementation Guide containing the FHIR profiles developed to reflect the common data model of the FAIR4Health Project. Configuration files for the onFHIR Repository so that onFHIR starts up with the FAIR4Health profiles.

#	Organisation or project that created the tool approach/ solution.	Name or title of the tool/ approach/ solution.	Challenge or use case the tool/solution addresses.
18	FAIRplus	FAIR Cookbook	Defined recipes for FAIRifying datasets, as well as more general topic guidance
19	FAIRplus	Dataset Maturity Model	Assess dataset maturity using indicators based on the FAIR principles
20	FAIRsFAIR	FAIR Adoption Handbook for Universities	This is a teaching and training handbook for higher education institutions to help universities to apply the competence framework to their specific situation and needs. It does so by providing ready-to-use model lesson plans on a variety of topics, including FAIR data, Data Management Plans (DMPs), repositories, data creation and reuse. The handbook also offers FAIR competence profiles and learning outcomes for the bachelor, master and doctoral levels, as well as information on course design and the implementation of the FAIR principles at the institutional level.
21	FAIRsFAIR	FAIR Data Policy Checklist	A checklist to enable policymakers to self-assess whether their data policies are FAIR-enabling and a template to support them to describe the content of their policies in a structured and comparable way
22	FAIRsFAIR	ACME-FAIR: a guide for Research Performing Organisations	A capability Model and Guidance for FAIRenabling Organisations: "ACME-FAIR: a guide for RPOs": The overall purpose of ACME-FAIR is to help those managing and delivering relevant professional services to self-assess how they are enabling researchers and their colleagues to do just that. Each part deals with one of the key issues that Research Performing Organisations (RPOs) face in establishing the capabilities to put the FAIR principles into practice. It is informed by the project's engagement with community initiatives to 'turn FAIR into Reality', and by the report of the same name. It is recommended that universities, institutes and other RPO consider providing these capabilities as vital steps towards "FAIR-enabling practice". Each of the



#	Organisation or project that created the tool approach/ solution.	Name or title of the tool/ approach/ solution.	Challenge or use case the tool/solution addresses.
			7 guides has a thematic introduction, an overview of the relevant capabilities, and a rubric for assessing the levels of maturity and community engagement for each capability.
23	FAIRsFAIR	FAIR-Aware	The FAIR-Aware tool provides practical information and resources to (further) develop skills for FAIR data and is meant to incentivise researchers to make their data FAIR. This tool can be used both as a teaching tool and as a resource for researchers and data stewards.
24	FAIRsFAIR	F-UJI: Automated FAIR Data Assessment Tool	F-UJI is a service based on REST, piloting a programmatic assessment of the FAIRness of research datasets in five trustworthy data repositories. The F-UJI assessment is based on 16 out of 17 core FAIR object assessment metrics developed within FAIRsFAIR and each corresponding to a part or the whole of a FAIR principle. F-UJI adheres to existing web standards and PID resolution services best practices and utilises external registries and resources such as re3data and Datacite APIs, SPDX License List, RDA Metadata Standards Catalog, and Linked Open Vocabularies (LOV).
25	FAIRsFAIR	FAIR-enabling Repository Finder	The Repository Finder is a searchable registry of repositories with embedded content and metadata. Through an iterative process, FAIRsFAIR further improved and reshaped the tool based on community consultation and feedback and merged it into DataCite Commons. With repositories being visible in DataCite Commons, the tool allows users to search for repositories based on filters and additionally explore their data objects, contributors, and context. Moreover, repository metadata is embedded in the PID graph to allow for enhanced machine-readable context information on research data

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26	FAIRsFAIR	Framework for assessing FAIR Services	The FAIRsFAIR service assessment framework helps users self-assess how well their research data infrastructure services support FAIR data. The framework focuses on providing guidelines on how services can be made to optimally improve the FAIRness of the data that they are used for.
27	FAIRsFAIR	CoreTrustSeal+FAIRenabling Capability Maturity Model	The CoreTrustSeal + FAIRenabling Capability Maturity Model supports tiered self-assessment as a trustworthy digital repository (TDR) alongside FAIR enabling status, with a view to developing and improving practice. In addition to supporting preparation for formal CoreTrustSeal certification it can be used by a wider range of data and metadata services to assess their organisational, digital object management, technology and security practices with a FAIRenabling perspective.
28	FAIRsharing	FAIRassist	The FAIRassist tool, part of the FAIRsharing resource offers personalised guidance to discover resources such as data & metadata standards, and databases which should be used to make data FAIR.
29	GO-FAIR and IOS Press	FAIR Connect	FAIR Connect is an Open Access publishing platform for the development and dissemination of good practices for professional FAIR-Data stewardship. The platform will facilitate and support the (citable) publication of FAIR descriptions, complemented with concise living review articles, limited to FAIR Supporting Resources (FSRs). Drawing on our 35 years of academic publishing experience, IOS Press will help build FAIR Connect as an online, open access, ISSN-registered journal devoted to the dissemination and review of good practices in data stewardship. It is FAIR Connect's mission to empower and unite data stewards around the world in their common goal of research FAIRification.

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30	LifeWatch ERIC, with support from the European Regional Development Fund (EU), the Ministry of Universities and Research (Italy), the National Operational Programme on Research and Innovation 2014-2020 (Italy), and LifeWatch Italy.	EcoPortal	EcoPortal is a repository for semantic artefacts that pertain to Ecology and Biodiversity. It hosts relevant ontologies and controlled vocabularies together with their metadata and it offers a suite of tools to discover, publish or utilise them. Semantic artefacts are associated to scientific domain categories, rendered public or private, and edited through a seamless workflow that makes use of our integrated instance of VocBench. Published versions of the semantic artefacts may also be assigned DOIs upon request, a feature we offer in collaboration with DataCite. EcoPortal additionally offers an API for ready accessibility and use of the hosted resources in other environments, an Annotator tool for annotating text, a Mapping tool for identifying potential similar concepts within the repository, and a Recommender to match ontologies and thesauri to users' needs.
31	NI4OS-Europe	RePol	
32	NI4OS-Europe	LCT – License Clearance Tool	

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33	NI4OS-Europe	RoLECT	EOSC Rules of Participation Legal & Ethics Compliance Tool Guided compliance self-assessment for legal and ethics EOSC RoP. Targets service providers, researchers and research organisations. Structured flow providing logic steps for testing a potential EOSC service/dataset against current RoP.
34	Observatoire de Paris (France)	Online IVOA validator for Astronomy services	The online tool allows data centre and data repository managers to assess the compliance of their web services or digital object with respect to the IVOA (International Virtual Observatory Alliance, <a href="http://ivoa.net">http://ivoa.net</a> ) standards.
35	Parthenos Project	Course: Formal Ontologies: A Complete Novice's Guide	This module is specifically aimed at those who are not yet familiar with ontologies as a means of research data management, and will take participants through some of the main features of ontologies, and the reasons for using them.
36	RDA I-ADOPT WG	I-ADOPT Interoperability Framework	The I-ADOPT Interoperability Framework is a set of guidelines based on a simple non-domain specific ontology that supports the decomposition of complex observable properties into their essential atomic parts represented through the concepts in FAIR terminologies. The I-ADOPT Interoperability Framework is a substantial contribution to enabling the interoperability of terminologies, within and across domains without sacrificing any prior efforts. It serves as a common layer of abstraction through which concepts from different terminologies can be systematically aligned and extended, as needed. The annotation of observational data with these interoperable concepts supports the findability and reusability of datasets across repositories facilitating the federation of data systems. It represents the variables' context and provides the level of detail needed to identify suitable datasets and to connect different datasets with related observations. The I-ADOPT Interoperability Framework will facilitate the

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			development of tools to enable researchers to describe and find their data more systematically.
<b>Additional tools, methods, resources suggested by consortium partners</b>			
37	AgroPortal project, supported by University of Montpellier and INRAE	Ontology FAIRness Evaluator (O'FAIRe)	O'FAIRe (Ontology FAIRness Evaluator) is a metadata-based automatic FAIRness assessment methodology for ontologies and semantic artefacts - a broader term to include ontologies, terminologies, taxonomies, thesauri, vocabularies, metadata schemas and standards. It is based on the projection of the 15 foundational FAIR principles for ontologies, and it is aligned and nourished with relevant state-of-the-art initiatives for FAIRness assessment. We propose 61 questions among 80% are based on the resource metadata descriptions. O'FAIRe has been implemented in the AgroPortal semantic artefact catalogue. O'FAIRe web service outputs both global and detailed scores (normalized) against the 15 FAIR Principles. O'FAIRe results are visualized and explained with new specific user-friendly interfaces (such as the FAIRness wheel) in order to help AgroPortal users improve the FAIRness of their resources. O'FAIRe is currently implemented in three different public ontology repositories ; in the future, we will deploy the service in other OntoPortal repositories.
38	AgroPortal project, supported by University of Montpellier and INRAE	AgroPortal (A semantic artefact catalogue for agri-food)	Vocabularies and ontologies in agri-food are spread out, in different formats, of different size, with different structures and from overlapping domains. There is a need for a common platform to receive and host them, align them, and enabling their use in agro-informatics applications. AgroPortal is an ontology repository (more generally a semantic artefact catalogue) for the agri-food domain which features ontology hosting, search, versioning, visualization, comment, and recommendation; enables semantic annotation; stores and exploits ontology alignments; and enables interoperation with the semantic web. The AgroPortal specifically satisfies requirements of the agronomy

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			community in terms of ontology formats (e.g., SKOS vocabularies and trait dictionaries) and supported features (offering detailed metadata and advanced annotation capabilities).
39	Caspar van Lissa (Tilburg University, the Netherlands)	WORCS: A workflow for open reproducible code in science	WORCS is a workflow that researchers can adopt to make their code open and FAIR. The workflow is implemented as a freely available R package, and combines version control in Git, PIDs for code and state-of-the art solutions for reproducibility.
40	DublinCore	Guide: DCMI Encoding Guidelines	Guidelines for encoding digital objects using DCMI (Dublin Core Terms).
41	INOSC (International Network of Open Science Communities)	The Open Science Community Incubator Program	The adoption of FAIR principles often requires a culture change amongst researchers at their local institutions. To make Open and FAIR practices normative, community engagement amongst researchers is pivotal. Open Science Communities (OSC) are places where researchers make their Open and FAIR practices visible and accessible to their peers, e.g. by organising workshops, focus groups, symposia and other forms of peer-to-peer knowledge exchange.

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			The International Network of Open Science Communities (INOSC) is a growing network of 18 local OSCs in 8 countries and is helping colleagues around the globe to set-up their own local OSC. You are invited to join their 12-week Open Science Community Incubator Program (for free!), to start your own local OSC and connect to the INOSC network. In this program, you will be guided through each of the steps of the OSC Starter Kit (available at <a href="http://www.StartYourOSC.com">www.StartYourOSC.com</a> ) For more information, check out <a href="http://www.osc-international.com">www.osc-international.com</a>
42	Library of Congress	Guide: METS Example Documents: Metadata Encoding and Transmission Standard (METS)	Example documents for encoding metadata using METS.
43	Library of Congress	Video: CESSDA Series on Variable Harmonization: Documentation and Best Management Practices	Increase knowledge of social science metadata and standards for documenting harmonized social science data. Topics include an introduction to social science variable harmonization, examples from international social science surveys, the use of international standard classifications and how to use metadata to construct FAIR variable harmonization documentation.
44	Ontology Engineering Group - Universidad	FOOPS! Ontology Pitfall Scanner for FAIR	Assessing FAIRness level for ontologies

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	Politécnica de Madrid		
45	Ontology Engineering Group - Universidad Politécnica de Madrid	Ontology Pitfall Scanner!	Ontology evaluation. Some of the aspects validated in OOPS! overlaps with FAIRness evaluation criteria for ontologies.
46	Ontology Engineering Group - Universidad Politécnica de Madrid	Chowlk	Ontology/Vocabulary documentation
47	Ontology Engineering Group - Universidad Politécnica de Madrid	Ontology	Ontology continuous integration and publication
48	Ontology Engineering Group - Universidad Politécnica de Madrid	Widoco	Ontology documentation
49	Ontology Engineering Group - Universidad Politécnica de Madrid	Linked Open Vocabularies	Ontology search and reuse
50	Ontology Engineering Group - Universidad Politécnica de Madrid	Best practices for implementing fair vocabularies and ontologies on the web	Guidelines for ontology/vocabulary development and publishing
51	OntoPortal Alliance	OntoPortal (a generic technology for semantic artefact catalogues)	The OntoPortal technology is co-developed by the OntoPortal Alliance, a consortium of researchers dedicated to promoting semantic services in scientific research based on shared domain-specific ontologies managed with the collaboratively developed OntoPortal software. The technology originally based on the NCBO BioPortal allows



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			anyone to set up a semantic artefact catalogue for a domain/project of interest. For instance: AgroPortal, EcoPortal, BioPortal, MatPortal are instances of the OntoPortal technology respectively for agri-food, ecology/biodiversity, biomedicine, and material disciplines.
52	Programming Historian	Guide: Code Reuse and Modularity in Python	Computer programs can become long, unwieldy and confusing without special mechanisms for managing complexity. This lesson will show you how to reuse parts of your code by writing functions and breaking your programs into modules, in order to keep everything concise and easier to debug.
53	Programming Historian	Guide: An Introduction to Version Control Using GitHub Desktop	Introduction to the basics of version control, which provides an understanding of why it is useful and how to implement basic version control for a plain text document using git and GitHub.
54	researchobject.org community	RO-Crate	RO-Crate has been established as a community effort to practically achieve FAIR packaging of research objects (digital objects like data, methods, software, etc.) with their structured metadata. RO-Crate is based on well-established Web standards and FAIR principles. For its common metadata representations, RO-Crate builds on schema.org, a mature and general mark-up vocabulary used by search engines including Google Dataset Search. RO-Crate libraries are available for Javascript, Python, Ruby and Java, and in addition any RDF tooling supporting JSON-LD can be used (e.g. for knowledge graphs)
55	Rotterdam Exchange Format Initiative (REFI)	REFI-QDA Codebook	The REFI-QDA Standard enables interoperability between participating Qualitative Data Analysis Software (QDAS or CAQDAS) programs. Projects can be exported from one program and opened in another where they are converted into the receiving program's format. The REFI-QDA Standard makes it possible to exchange projects between all software packages that support the XML exchange format.



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56	Signposting the Scholarly Web	FAIR Signposting	A method to expose machine-actionable navigation links that indicate downloadable resources, types and attribution – particularly for scholarly and institutional repositories which use persistent identifiers like DOIs. Signposting makes explicit the links between a typical HTML landing page and the downloadable resources that are available for the research object described by that landing pages, including content resources and machine-readable metadata such as in RDF, although the method is technology-agnostic in terms of metadata formats. It also links to persistent identifiers, both for the research object and its authors. Signposting uses existing standards to achieve this: Web Links (RFC8288) conveyed using a simple HTTP header, HTML <link> elements, and/or Linksets (RFC9264).
57	Università degli Studi di Roma 'Tor Vergata' ( <a href="http://www.uniroma2.it/">http://www.uniroma2.it/</a> ) supported by the European Commission through ISA <sup>2</sup> - Interoperability solutions for public administrations, businesses and citizens ( <a href="https://ec.europa.eu/isa2/home_en/">https://ec.europa.eu/isa2/home_en/</a> )	VocBench	VocBench is a web-based, multilingual, collaborative development platform for managing and sharing reference data, controlled lists of codes and terms, thesauri and ontologies, used to organise information. With persistent URIs, managed concepts are correctly referenced in any domain. Developed in a context neutral way as an open-source project, it can be deployed or further developed for any sector wanting to have authentic reference data/codes made available for information systems and human users.
58	University of Tübingen	CMDI2Marc21	A web service that allows metadata conversion from CMDI to MARC21 (XML)
59	University of Tübingen	CMDI2DC	CMDI2DC is a web-based tool designed to convert metadata from CMDI to Dublin Core.



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60	Utrecht University	Druid: Linked Data store for the humanities	Druid allows you to store your Linked Data. In addition, it provides tools to browse, query and visualise, and discover any Linked Datasets on Druid (and beyond!). Your private data can be stored as Closed Linked Data and setting up a SPARQL endpoint is literally the click of a button!