Deliverable D1.4 – DOME 4.0 Web Platform Final Release

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V0.4	2024-30-05	Amit Bhave	Final Review and Comments
V1.0	2024-05-31	Willem van Dorp	Formatting and finalization

Executive Summary

This document serves as a supplementary guide to the DOME 4.0 Web Platform, mapping out how to navigate the platform through its core functionalities and provides information about its implementation, testing and deployment infrastructure.

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1. Introduction

This document reports on the activities of Task 1.4 of the DOME 4.0 project, named "Web Platform Implementation and Deployment". The main outcome of this task is the DOME 4.0 Web Platform, which

is an industrial data ecosystem that enables the sharing of business-to-business (B2B) data for value generation and the creation of new or enhanced products, processes, and services. DOME 4.0 is open to all providers and users of data. It enables enhanced interoperability, discoverability, usability, and sharing of data, apps, and other online assets by relying on ontology and modern data processing. This report provides a walkthrough of the platform features, while all the other technical details are available as part of previous deliverables.

1.1 Objective

The main objective is to implement and deploy a Digital Open Marketplace Ecosystem (DOME). This task is built using the requirements collected in D1.2, the architecture designed in D1.3 and is supported by the T1.1 in integrating the building blocks of the platform, developed in WP2 (data tools), WP3 (core components like broker, connectors) and WP4 (B2B showcases) of the project. Our experience in previous projects like Marketplace, Market 4.0, and VIMMP has helped us in deciding upon the usage of certain technical parts of the platform and their implementation.

1.2 Key Functionality

The DOME 4.0 platform provides users with functionalities to enable data sharing and searching. The primary users of the DOME 4.0 platform are data consumers, who are looking for a centralised location to access data from multiple database platforms, and data providers, who want to share or sell their data. DOME 4.0 can also be deployed privately, to create a unifying location for data search and sharing across multiple databases within an organization.

The main functionalities of the platform are:

- An easy-to-use graphical user interface (GUI) for users to interact with the platform.
- Users can search multiple data platforms registered on the platform and filter results according to their need. They can either use the GUI or directly use the platform application programming interfaces (APIs).
- Users can register and catalogue their data on the platform.
- Users can register their database as a data provider with the platform.
- Users can register tools and services that can consume data from the platform to visualize data or run various simulations.
- Users can search through the catalogues registered on the platform directly as well as those from other platforms
- Provenance and sovereignty information of the data is stored and kept alongside the data as well as a special "ledger" and log keeping record of all transactions

Figure 1 shows an overview of user scenarios and the components responsible.

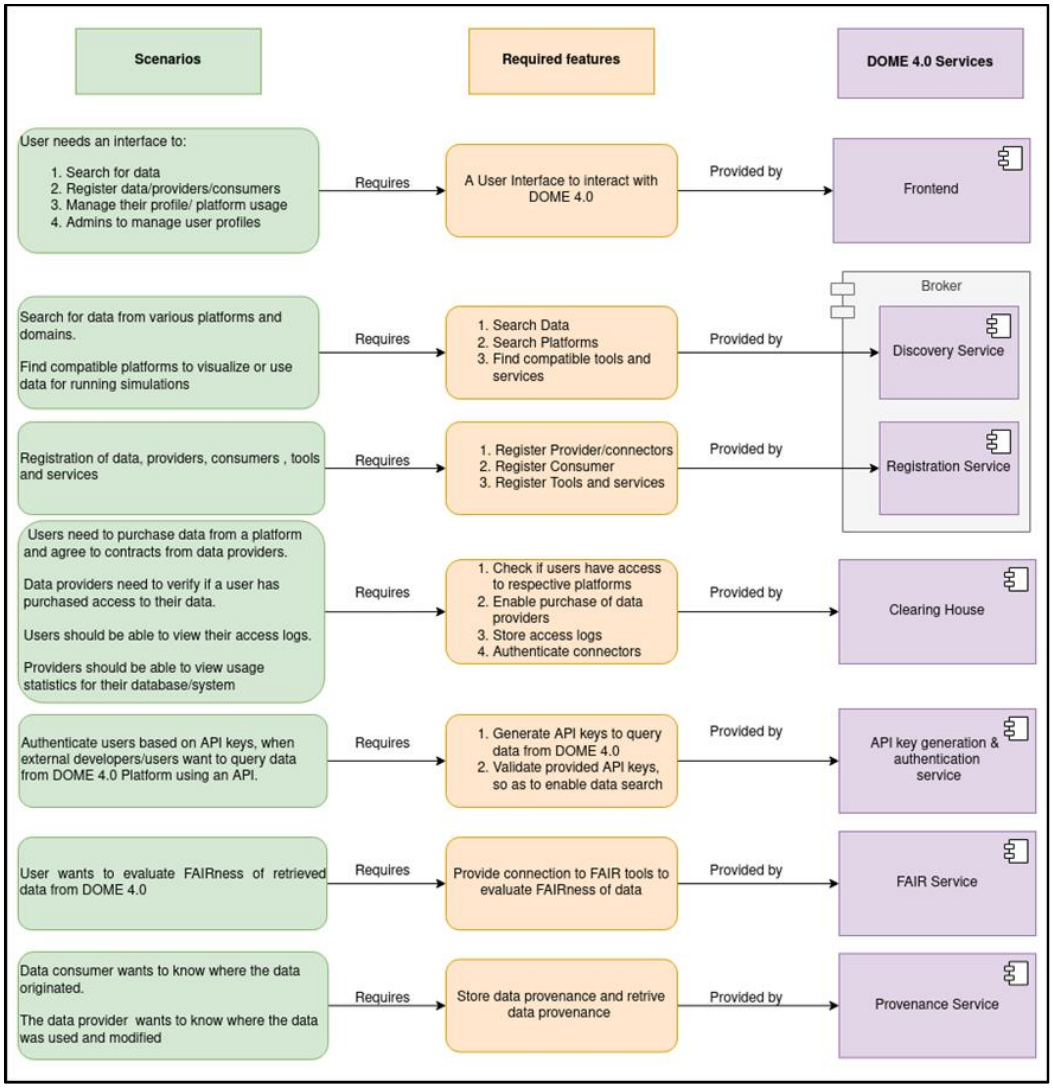

Figure 1: DOME 4.0 user-case scenarios and the services that are responsible to provide the required features

In the DOME 4.0 platform, all types of users, be it data providers or consumers must first register or Login to the platform. Here the access and user management are handled by Keycloak [5]. Keycloak serves as an efficient identity and access management solution, ensuring secure authentication and authorisation processes. Users are provided with two options, they can either login with GitHub or register themselves when they first log in, as shown in Figure 3.

On the welcome page of the DOME 4.0 platform, the only information for an unregistered user is the 'About' page and the 'Contact' page (which can take the user to the project website).

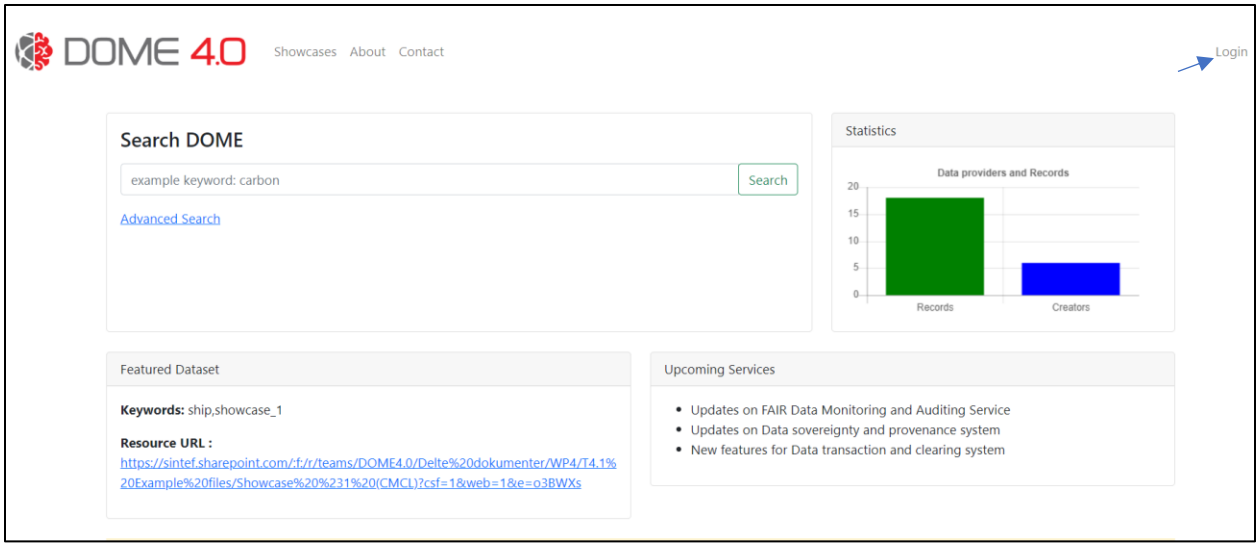

Figure 2: DOME 4.0 web platform welcome page

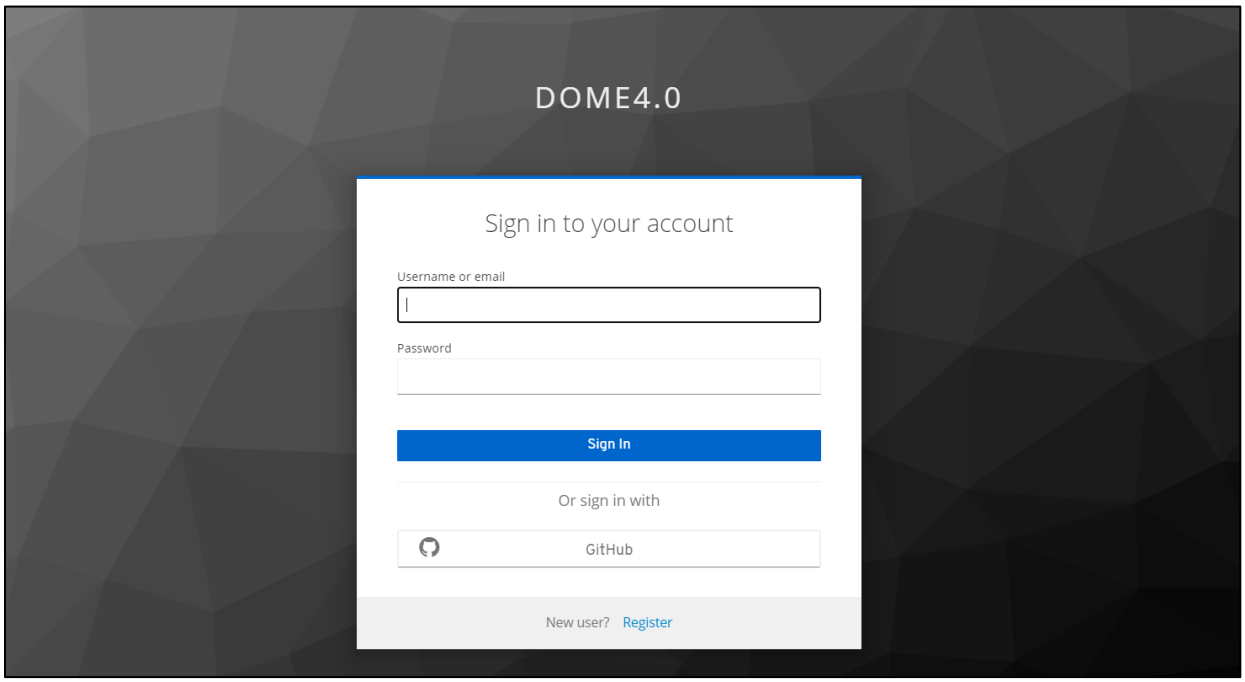

Figure 3: Keycloak login /register page

Once logged in, the user can now access all features of the DOME 4.0 platform. The user can find the list of registered data providers by clicking on the 'Data Sources' option as shown in Figure 4 and clicking into various data sources, information about that data source and provider is given, as shown in Figure 5.

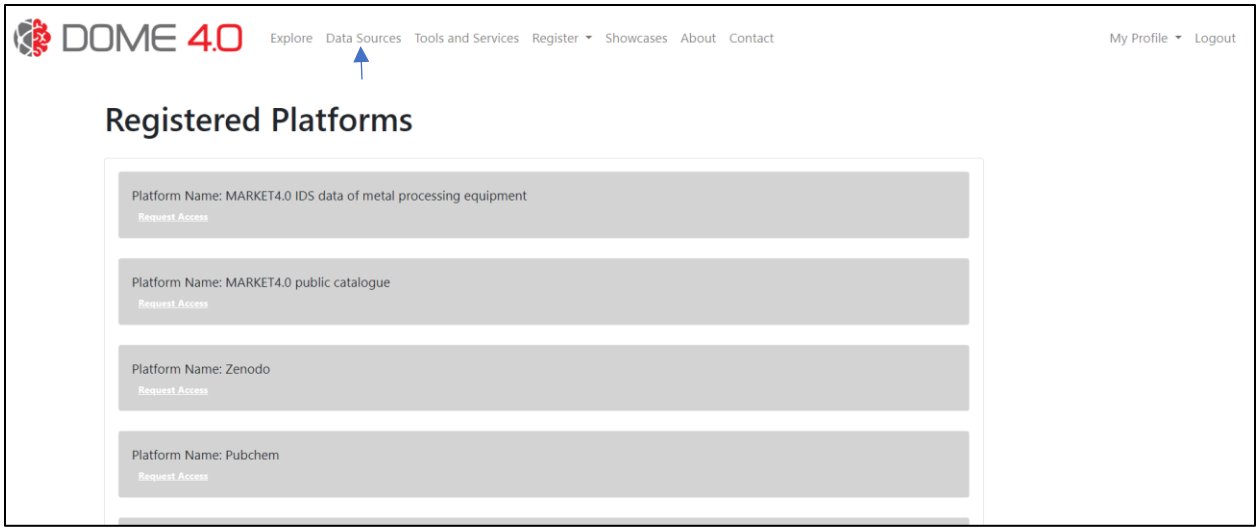

Figure 4: DOME 4.0 web platform – Data Sources page with list of registered data providers

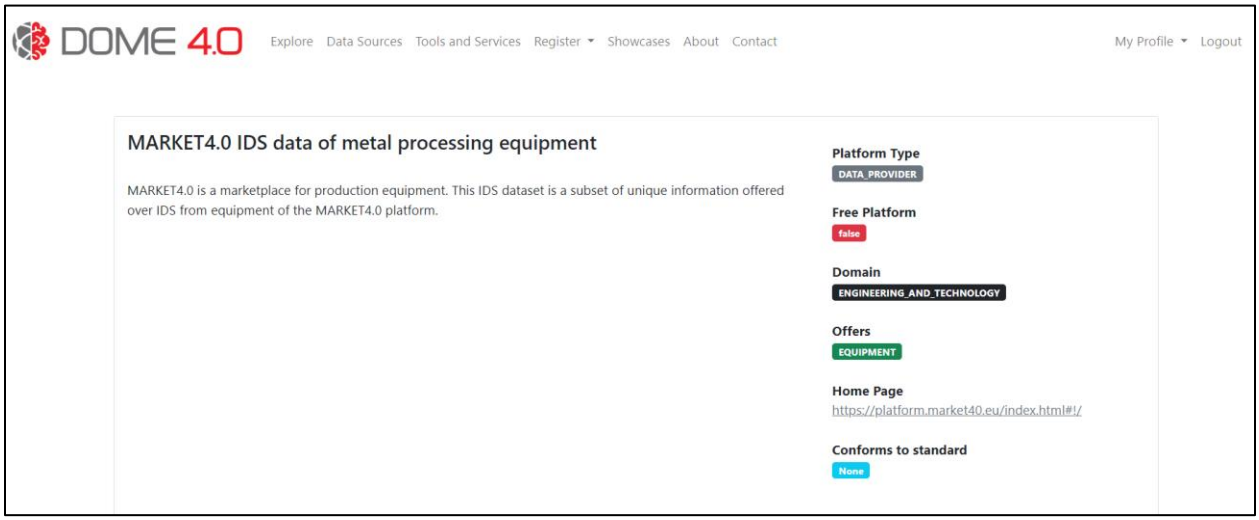

Figure 5: DOME 4.0 web platform- Data provider Information Page

Users can also find information on various tools and services available on the platform, by clicking the 'Tools and Services' option as shown in Figure 6 below. The tool/service offers the user more information on what the tool does as shown in Figure 7.

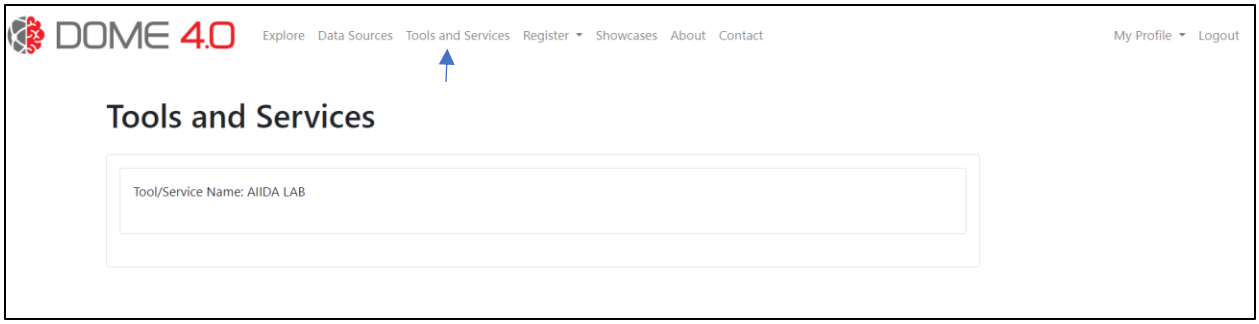

Figure 6: DOME 4.0 web platform – Tools/ services page with list of registered tools and services

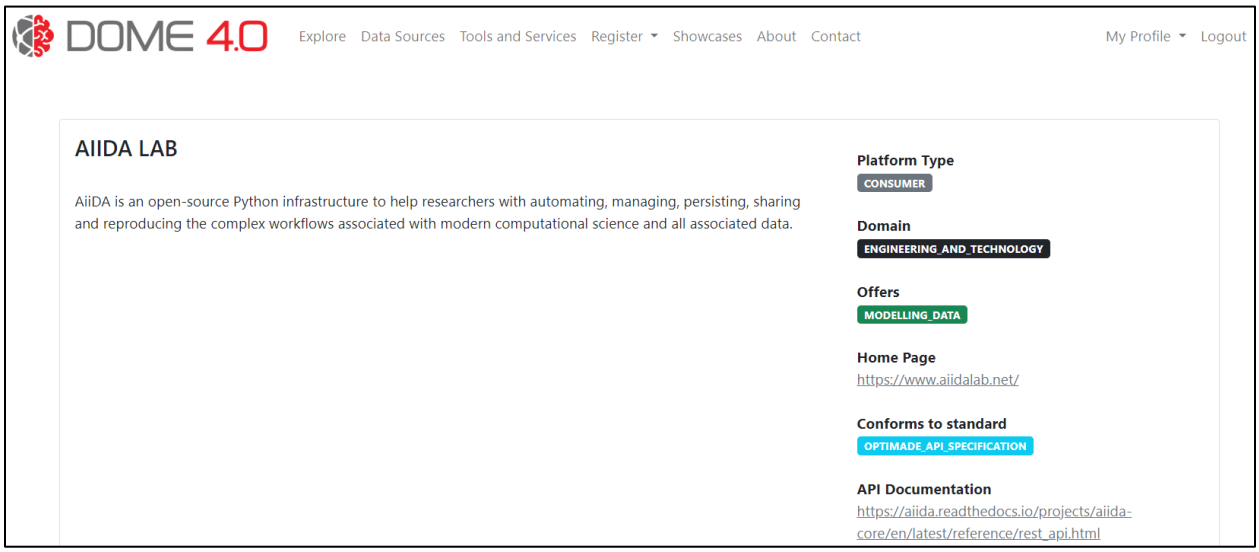

Figure 7:DOME 4.0 web platform – Tools/ service information page

To search data on the DOME 4.0 platform, we can either search from the welcome page as in Figure 2 or by going into the 'Explore' option and using the search field in that page as shown in Figure 8. When you search from the welcome page, if the user has already logged in, the search would take you to the explore page where the results are displayed. You can choose the relevant search results and navigate into it, and you can see the metadata and data as shown in Figure 9.

If the data has some relevant and compatible tool or service registered with DOME 4.0, a button is available to the user, enabling them to open the data in the tool or service to manipulate or visualise it, as shown in Figure 10. Here the data is compatible with AiiDAlab, so it opens the data in AiiDAlab in a separate window as shown in Figure 11.

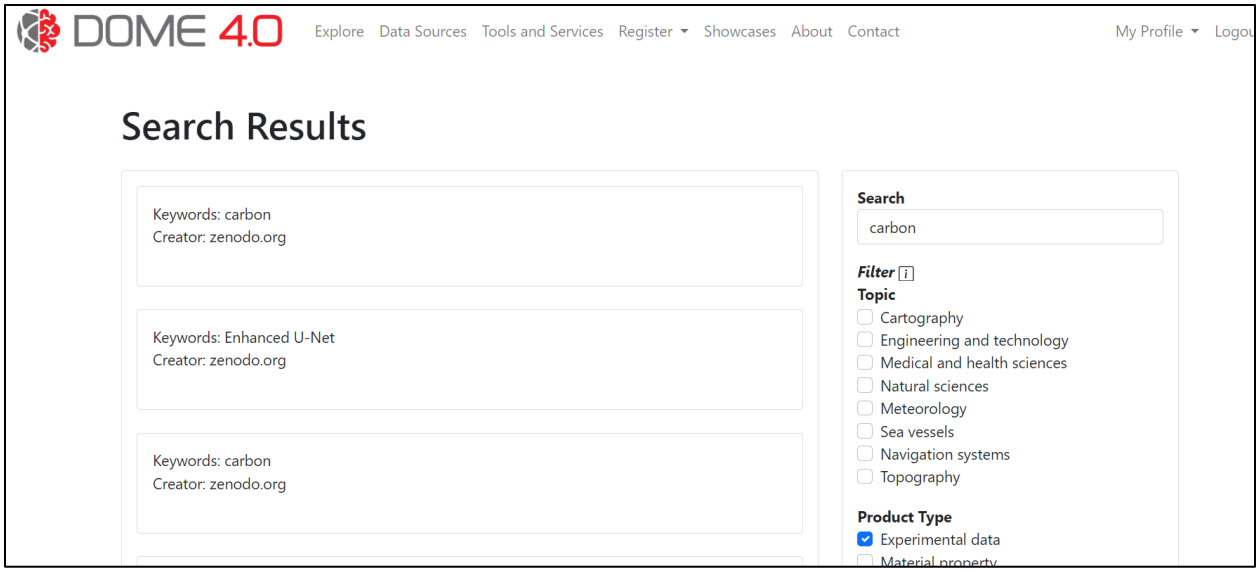

Figure 8: DOME 4.0 web platform – Search results List page

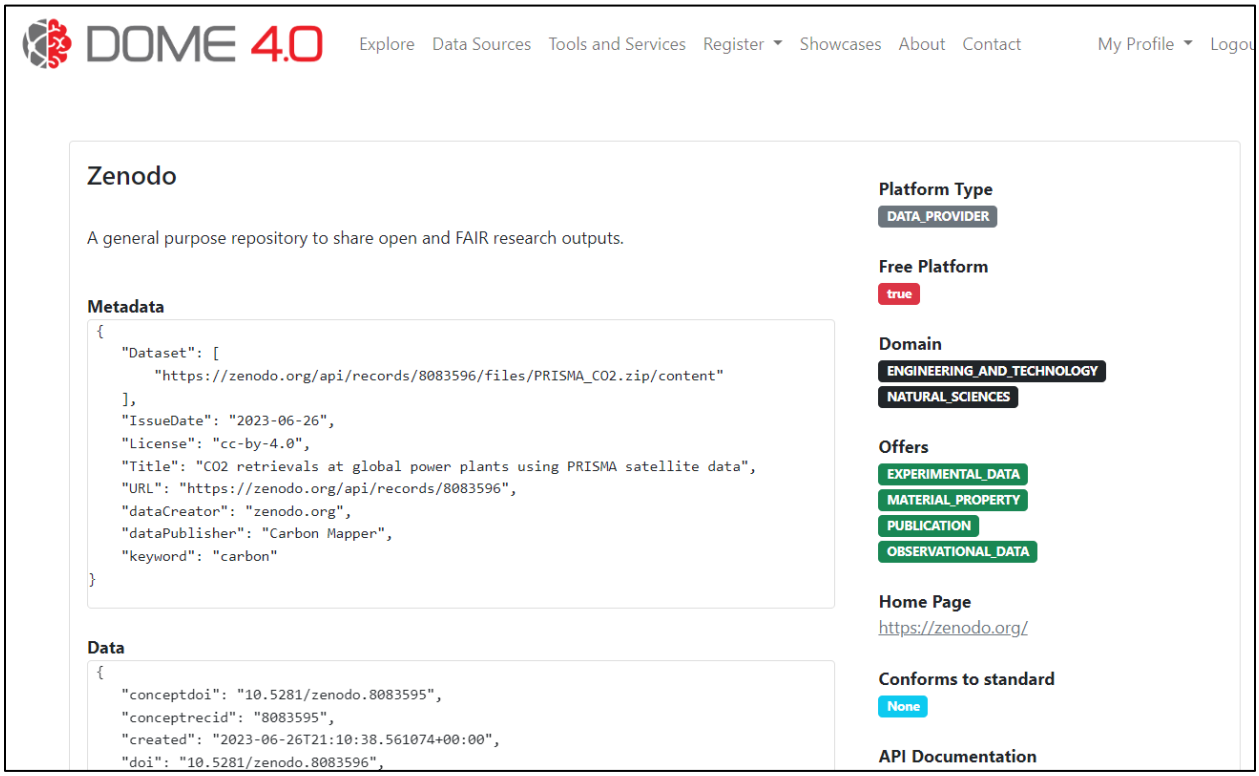

Figure 9: DOME 4.0 web platform – Search results instance page

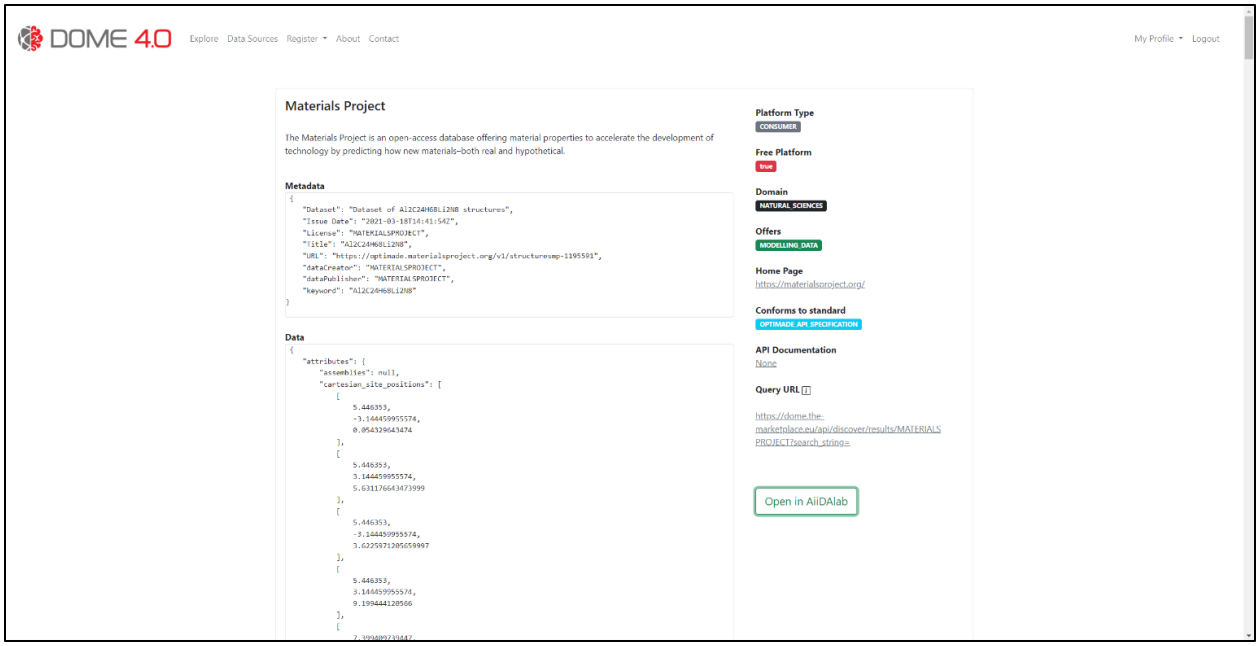

Figure 10: Page showing a data instance and its metadata. The "Open in AiiDAlab" button on the right shows that the data is compatible with AiiDAlab. The query url can be used to access the connector through an API.

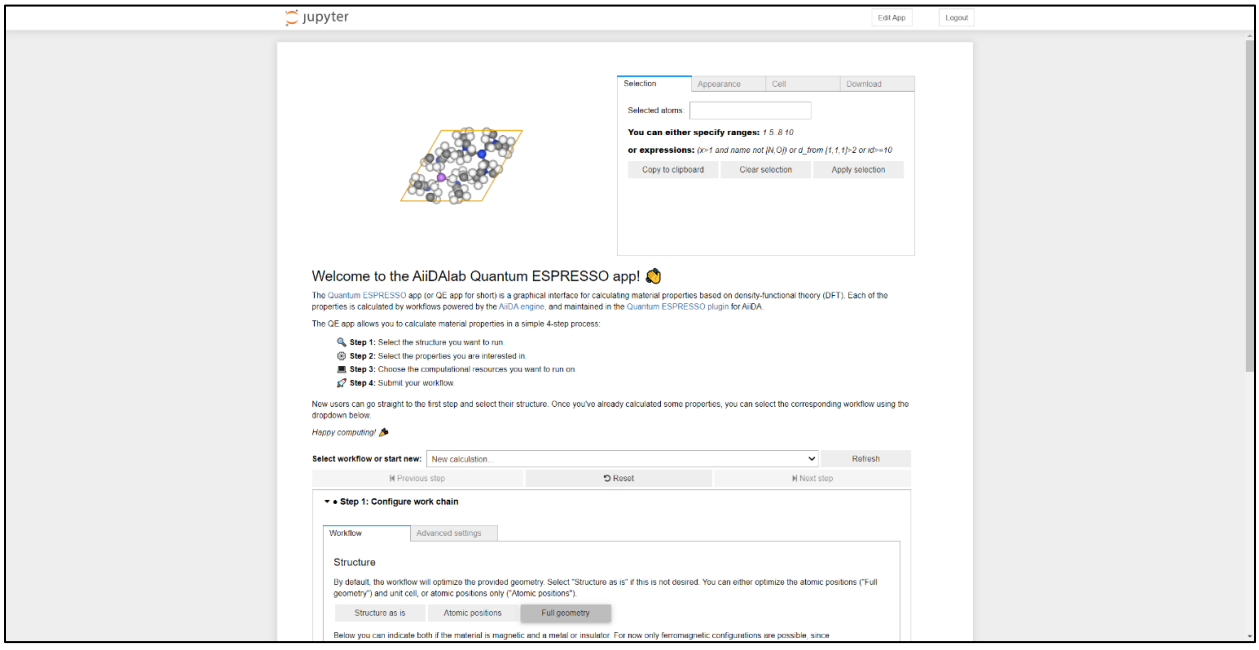

Figure 11: The AiiDAlab Quantum ESPRESSO app, here visualising the data instance, opened by clicking the "Open in AiiDAlab" button in Figure 10.

Also in Figure 10, alongside the data, the query URL field is available, this can be used to query the provider for data in case it is to be fed to a machine directly. To use this query URL, the user needs to generate an Access key which helps DOME 4.0 authenticate the machine uses and check if access is granted from that data provider. An Access key can be generated from the Access Keys page, which can be navigated from the 'My profile' dropdown and choosing the 'Access keys' option as shown in Figure 12.

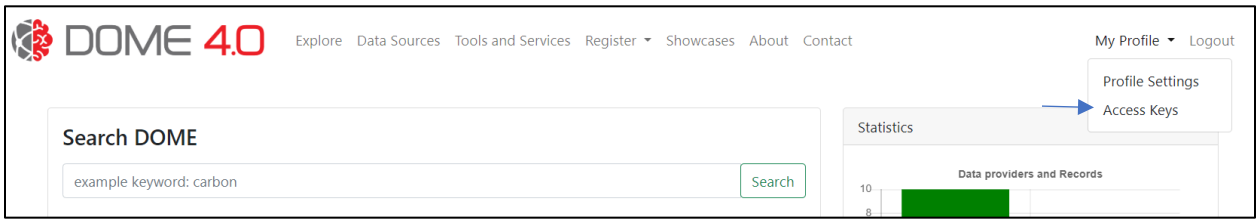

Figure 12: Access key Option

An Access key can be generated by filling in the form below in Figure 13 and clicking the 'Generate' button. When the key is generated, it is displayed only once to be copied as shown in Figure 14. Also, this Access Keys page shows the list of previously generated Access keys and if any Access keys are compromised, it has the option to delete the keys as well.

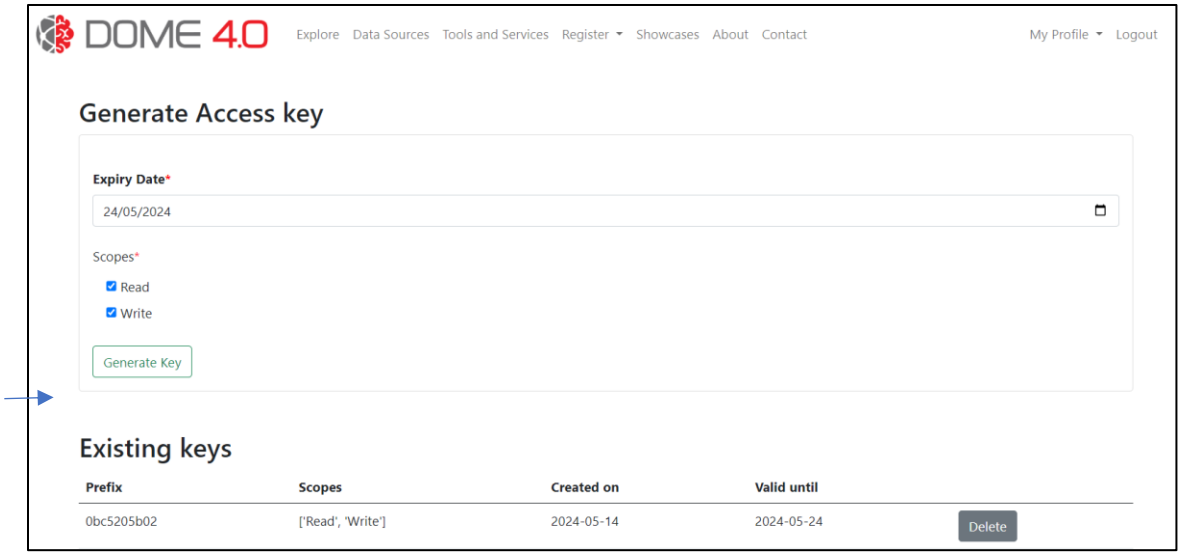

Figure 13:Access key Generate form

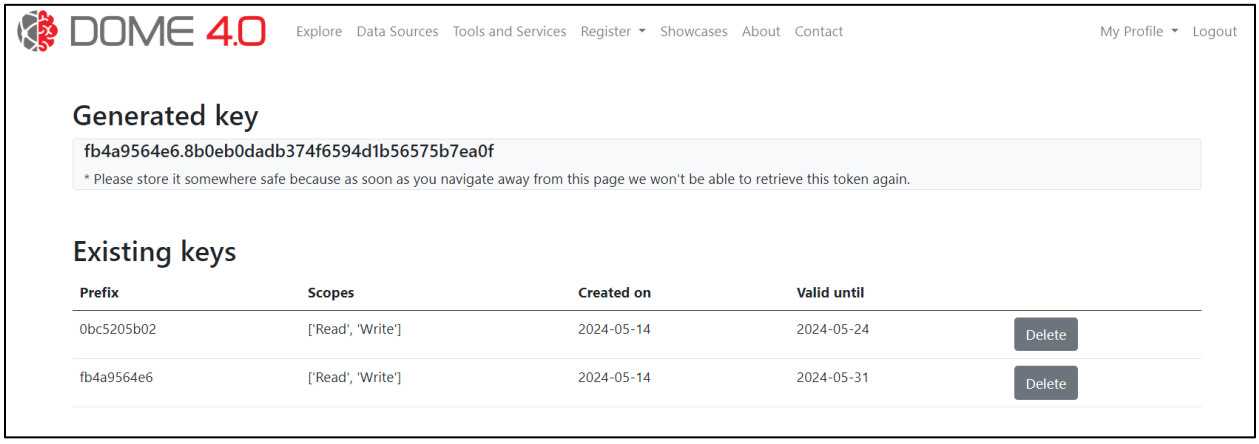

Figure 14: Access keys page after key generation

The Access key obtained can subsequently be utilised for querying, by including it in the header of the request. This process is depicted in Figure 15. The depicted image shows general querying of all platform data sources and not just a particular data provider. However, substituting the URL with the query URL provided on the data page of the provider, as depicted in Figure 10, will provide results specific to the data provider/source.

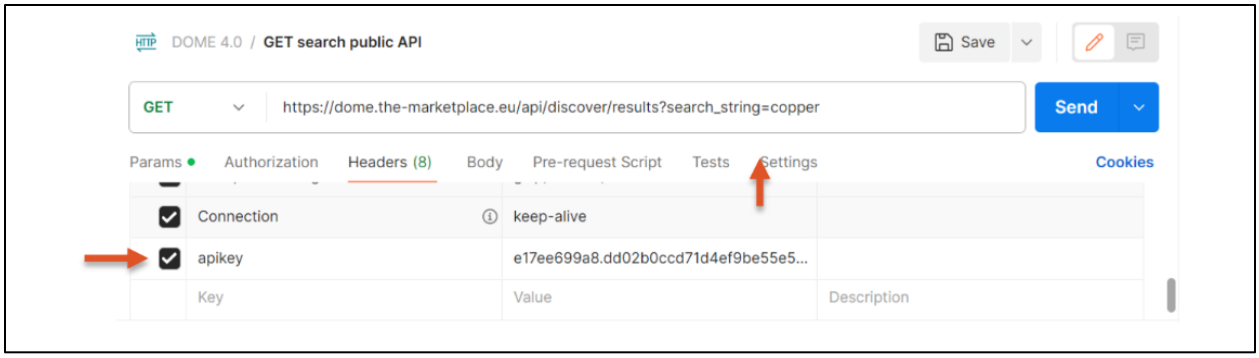

Figure 15: Querying DOME 4.0 results using Broker API

The user can also see the list of DOME 4.0 showcases, when choosing the option 'Showcases', as shown in Figure 16, and by clicking on the respective showcases they can see the use case and further information with respect to a particular showcase, as shown for showcase 1 in Figure 17.

Figure 16: Page showing list of showcases

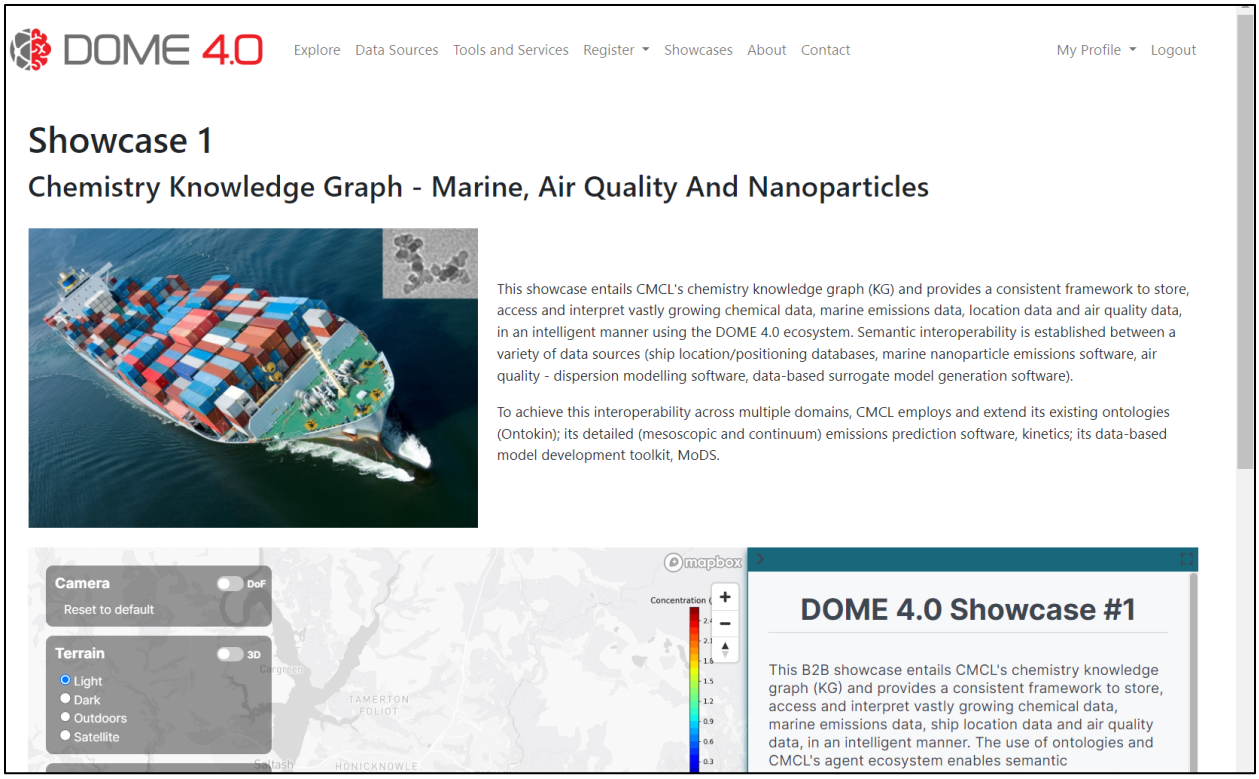

Figure 17: Showcase details page

For all the above features to work and make sense, DOME 4.0 requires registered data catalogs, data sources and providers, and data consumers, tools and services. To make this registration easy we provide forms in the DOME 4.0 platform under the *Register* tab. There are 3 registration forms available (delivered and implemented as part as D1.4, D3.3 and D3.5):

- The first option is 'Upload Catalog Data', which is for registering data catalogs as depicted in Figure 18. The 'Upload Catalog Data' option facilitates the registration of data catalogs, providing a structured approach for documenting and accessing data assets.
- The second option is to 'Register As Provider', as depicted in Figure 19, this provides information on how DOME 4.0 can connect to the data Source to fetch data and document other information about the data source/provider.
- The third option is to 'Register a Tool/Service', as depicted in Figure 20, this documents about the tools and service and how to connect to it. This is the form to be used by a service or tool provider.

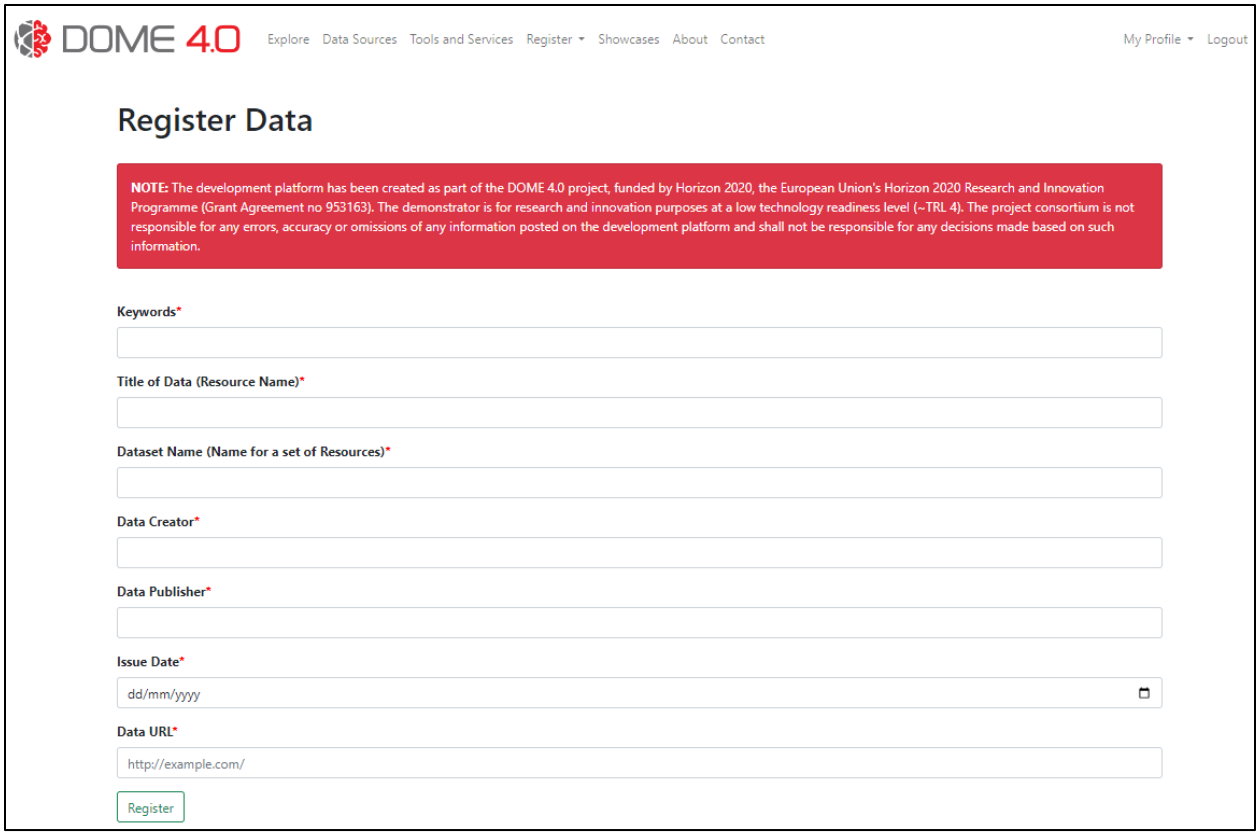

Figure 18: DOME 4.0 web platform – Data set registration form

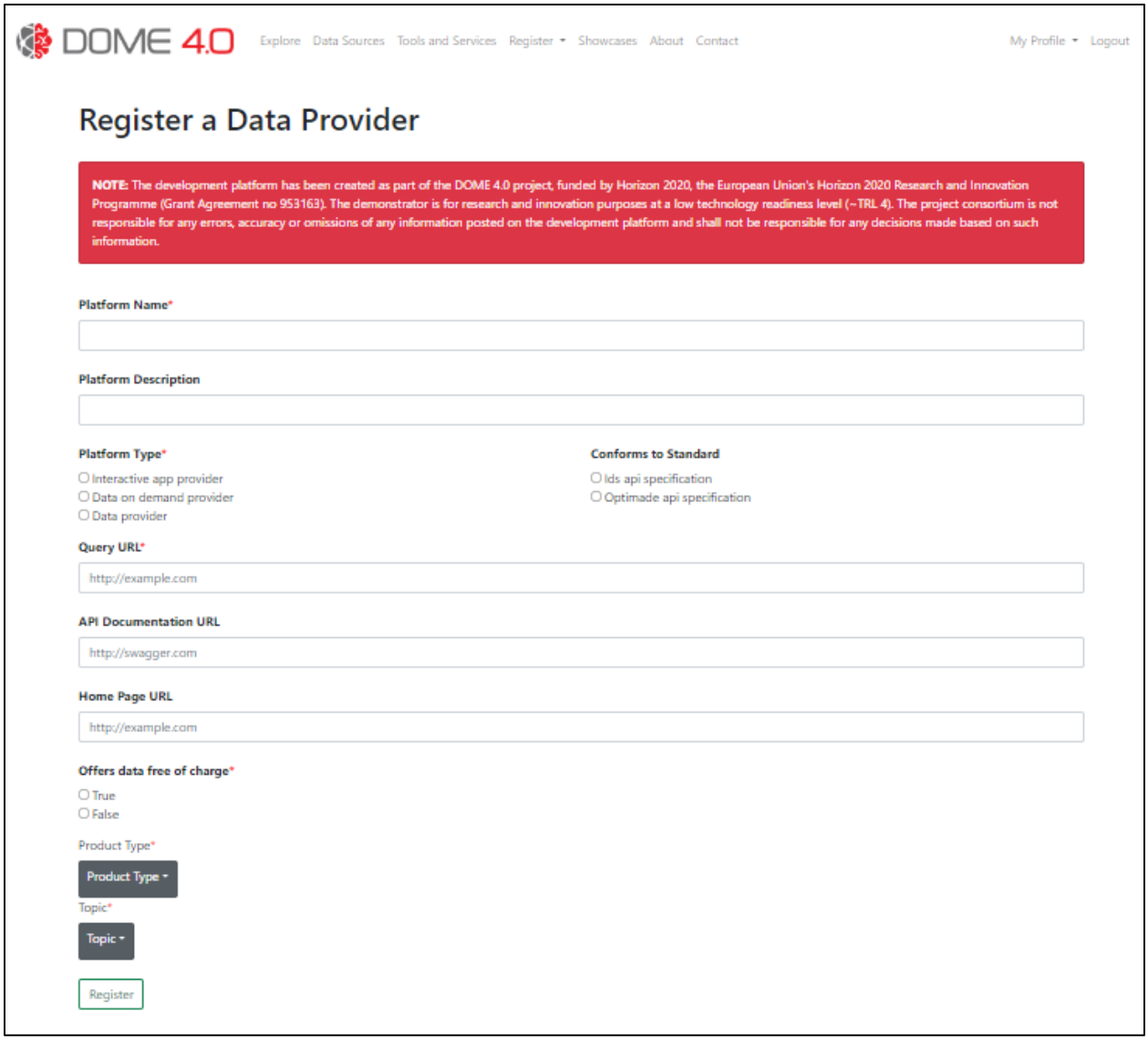

Figure 19: DOME 4.0 web platform – Data Source / data provider registration form

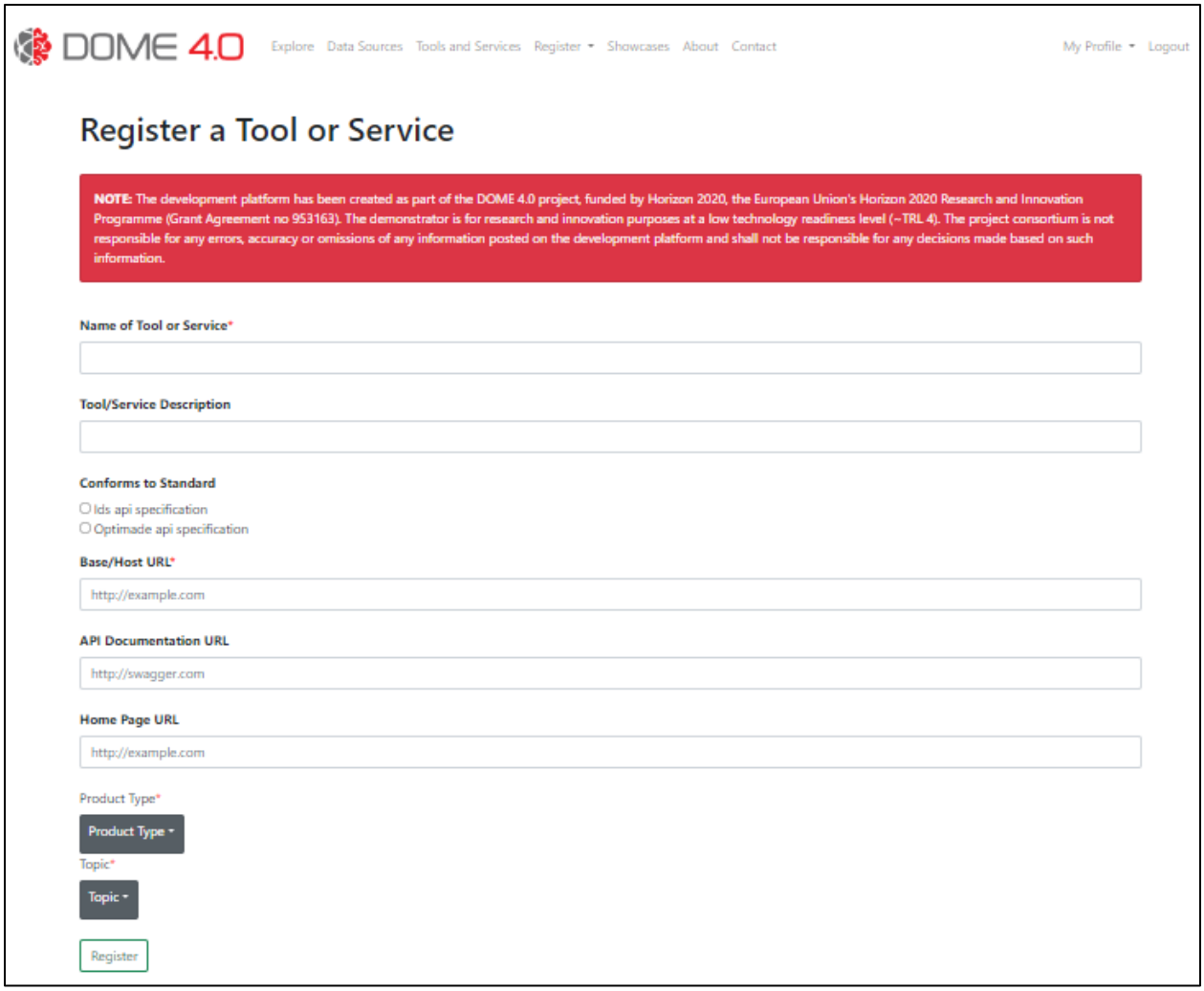

Figure 20: DOME 4.0 web platform – Tools and services provider registration form

In the background, a system for logging the data provenance and sovereignty exists. This system initially used a Hyperledger Fabric blockchain technology to track where data originated, and what licenses apply to a given data set in addition to other relevant provenance and sovereignty information. However, as shown in Figure 21, the performance is slow enough to impair the user experience, even though the current solution does all it is supposed to do. As a result a new system based on the built in ontology, and running an internal log of transactions

has been implemented.

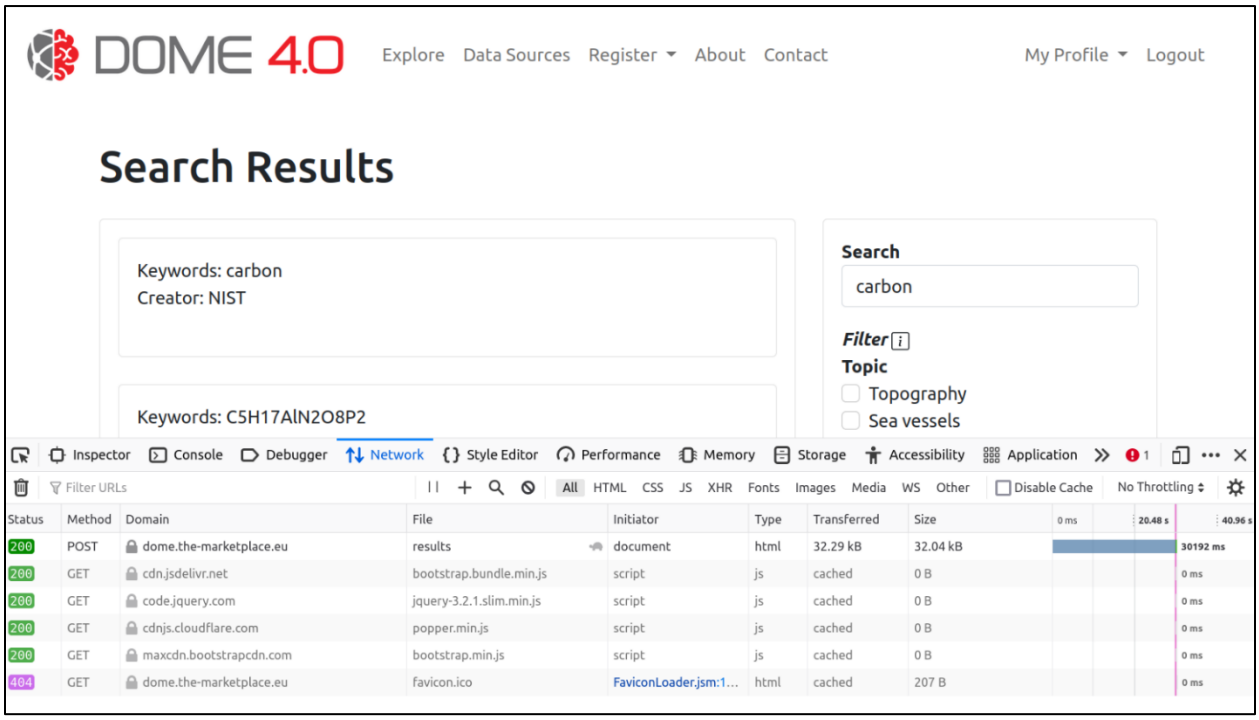

Figure 21: A screenshot showing the speed at which a DOME 4.0 search gets executed. Returning a result took over 30s in this case, in part because of the effort and time spent accessing the Hyperledger service.

2. Platform Development

2.1 Implementation

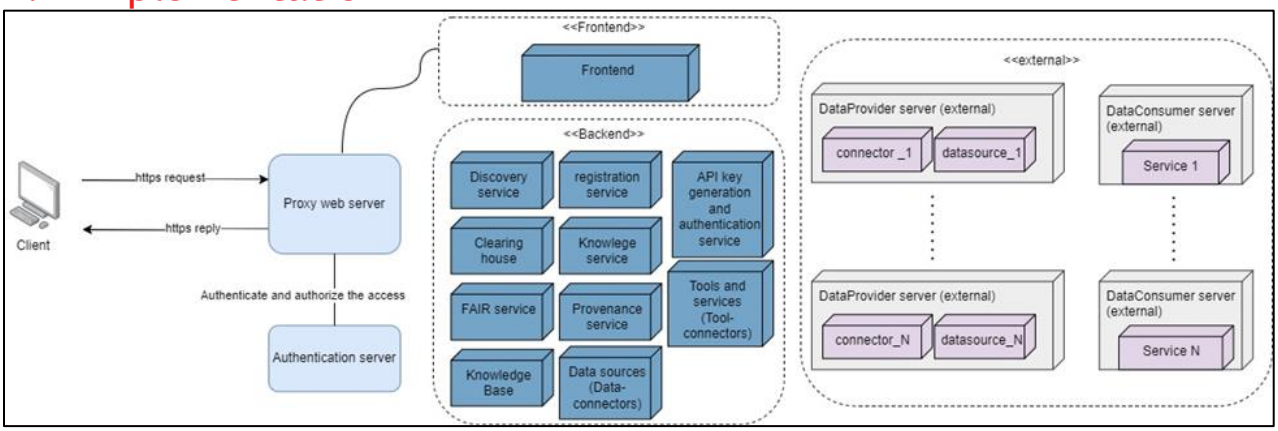

Figure 22: System overview of the DOME 4.0 ecosystem

The DOME 4.0 platform is implemented as a web service, adopting a microservices architecture, facilitating scalability, flexibility, and easier maintenance of individual components, as discussed in D1.3 report and in Figure 23 above. The implementation uses GitHub [3] as the central repository for collaboration, utilising git for version control. GitHub and git provide an environment to efficiently manage codebase iterations and track changes (Figure 24). Adhering to agile methodologies, we prioritise iterative development and collaboration, ensuring rapid delivery of features and responsiveness to evolving requirements, as set in place at the project outset.

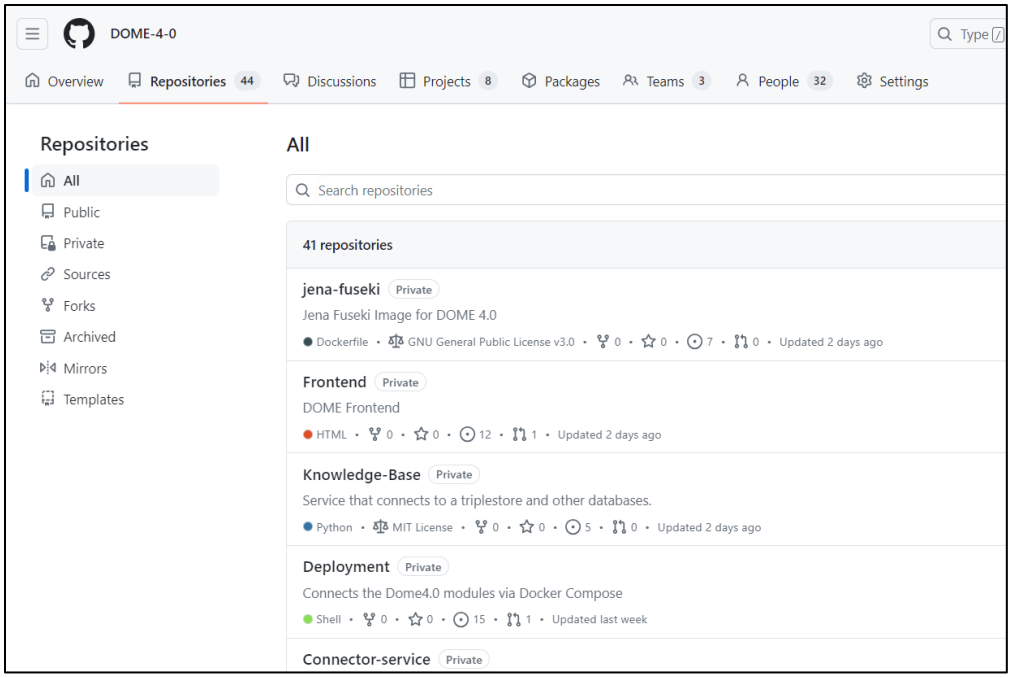

Figure 23: Code repository for DOME 4.0

2.2 Testing

Before deploying features to production, we conduct testing on an identical server known as our staging server. This allows partners and developers to evaluate the features. Once testing is completed and approved, we proceed with deploying to our production environment.

Various testing methods used:

1. **Manual Testing**: Once new features are deployed to staging, the partners and other developers are expected to test the new features and provide feedback.
2. **API Testing**: Developers will test the functionality and reliability of the service APIs by sending requests and verifying responses using the API client Postman.
3. **Data Testing**: Developers validate the integrity and accuracy of data stored and retrieved by our services. This is to ensure that data manipulation operations (e.g., CRUD operations) work as expected.
4. **Unit Testing:** Writing and executing unit tests for individual components to ensure their correctness and reliability.
5. **Integration Testing:** Testing the interaction between different modules or components to validate the system's behavior.
6. **End-to-End Testing:** Conducting end-to-end tests to simulate real user scenarios and ensure the entire application functions correctly from start to finish.
7. **Continuous Integration:** Automatically running workflows on GitHub through GitHub Actions. We have set it up to run pylint, along with other static analysis tools, to check the codebase for

adherence to coding standards, potential bugs, and stylistic issues. This step ensures that the codebase maintains a consistent quality level and follows best practices.

3. Platform Deployment

Every DOME 4.0 component and service is equipped with a Continuous Integration and Continuous Deployment (CI/CD) setup in its repository. Consequently, the workflows execute tests, checks, build the Docker image, and subsequently push it to the designated GitHub container registry.

Our platform is currently deployed on two servers: A staging server [1], which is a test system; and a production server [2]. Deployment is entirely automated through GitHub Actions, initiated with a simple click. The workflow accesses the DigitalOcean [4] hosted servers and Docker images of all DOME 4.0 platform components from the GitHub container registry linked with the relevant GitHub repositories and constructs the complete platform. Once the workflow is complete, the platform will be up and running and available in the staging or production server as specified in the workflow. The deployment workflow pages, and GitHub Actions is shown in the Figure 25 and Figure 26 below.

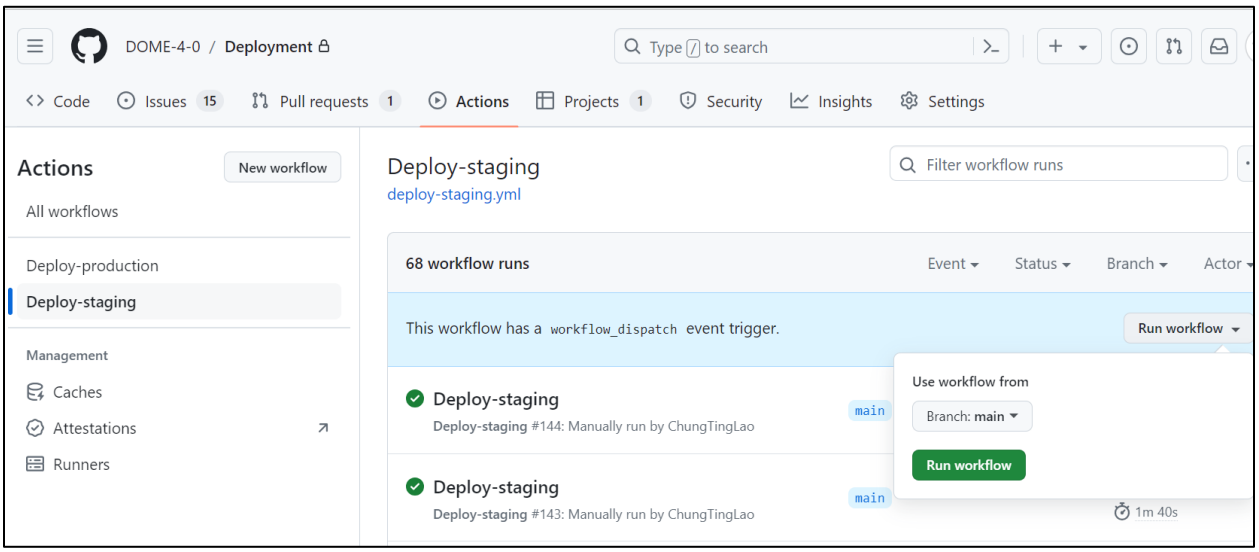

Figure 24: GitHub Actions

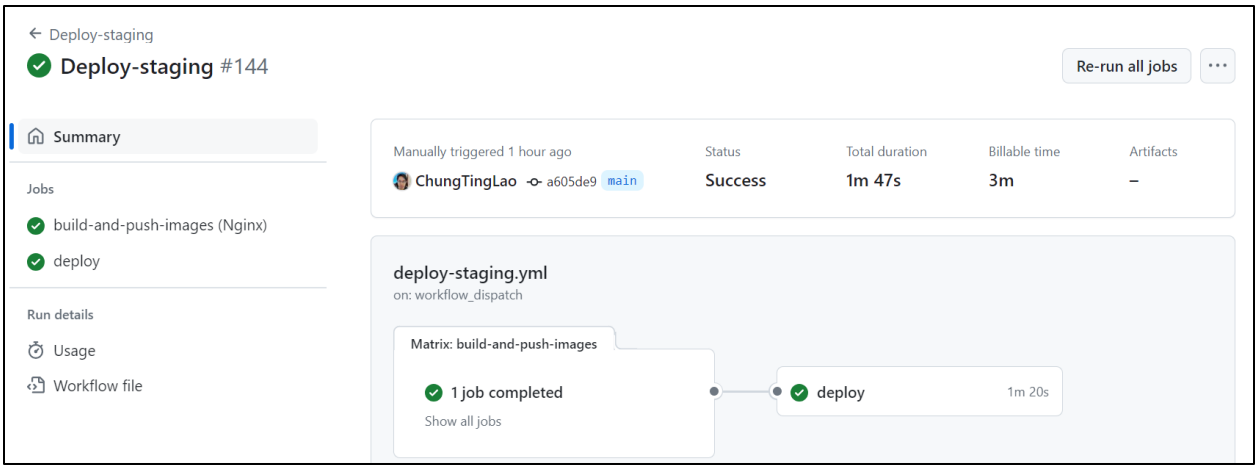

Figure 25: GitHub worflow- to deploy to staging system

4. Conclusions / Next steps

As part of this task, we have developed, deployed, and tested the DOME 4.0 platform. Looking ahead even though this is the final release of the platform as part of this project, the platform will continue to be developed for improvements (based on user feedback) in the upcoming months, as part of the technical WPs.

5. Lessons learnt

We began the project by launching a basic version of the product to showcase the new features and support gradual technical development. This method worked well, as it simplified discussions and integration of additional functionalities. Starting with a minimum viable product (MVP) allowed us to promptly confirm the main ideas of the application and prioritise features according to proven feedback, leading to a smoother and more user-focused development journey.

Utilising a staging server (while the production being on cloud) for testing purposes significantly enhanced the development process by enabling feedback from external partners within the rapid development cycle. This emphasised the importance of incorporating such testing environments for effective collaboration and validation, while reducing the on-cloud server and services costs to minimal.

Implementing separate services for different components of the DOME 4.0 platform proved instrumental in our development approach. This gave us flexibility in swapping components and concurrently developing various features. For instance, the ability to swap a specific microservice technology (triple store) mitigated the risk of vendor lock-in.

Maintaining separate GitHub repositories for different components of the project helped with efficient development and collaboration. This approach allowed team members to focus on specific areas of the platform, streamlining the development process, and reducing conflicts.

Using individual repositories enabled easy version control and tracking of changes for each component. This granular approach enhanced transparency and accountability within the team, as developers could monitor modifications specific to their assigned tasks, leading to better organisation and management of the project.

6. Deviations from Annex 1

None.

7. References

[1] Staging/Test Platform: https://dome-staging.the-marketplace.eu/
[2] Production Platform: https://dome.the-marketplace.eu/
[3] GitHub Repository: https://github.com/DOME-4-0
[4] Digital Ocean: https://www.digitalocean.com/
[5] Keycloak: https://www.keycloak.org/

8. Acknowledgement

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

Project partners:

#	Type	Partner	Partner full name
1	SME	CMCL	Computational Modelling Cambridge Limited
2	Research	FHG	Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung E.V.
3	Research	INTRA	Intrasoft International SA
4	University	UNIBO	Alma Mater Studiorum – Universita di Bologna
5	University	EPFL	Ecole Polytechnique Federale de Lausanne
6	Research	UKRI	United Kingdom Research and Innovation
7	Large Industry	SISW	Siemens Industry Software NV
8	Large Industry	BOSCH	Robert Bosch GmbH
9	SME	UNR	Uniresearch B.V.
10	Research	SINTEF	SINTEF AS
11	SME	CNT	Cambridge Nanomaterials Technology LTD
12	University	UCL	University College London

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9. Table of Abbreviations

Abbreviation	Explanation
GUI	Graphical User Interface
API	Application Program Interface