Orchestrating an interoperable sovereign federated Multi-vector Energy data space built on open standards and ready for GAia-X

D2.2 Data Space initiatives/projects in EU and BRIDGE alignment

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List of Contributors	
Bruno Traverson	EDF
Eric Lambert	EDF
Alzennyr Gomes Da Silva	EDF
Maria Inês Marques	EDP
Erik Maqueda	Tecnalia
Shani Tiran	IDSA
Silvia Castellvi	IDSA
Isidoros Kokos	ICOM
Javier Valiño	ATOS
Martina Galluccio	RINA-C
Adriënne Heijnen	AU

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Reviewer 2	Enrico Marchegiani. REVOLT	19/04/2023
Reviewer 1	Sebastiaan Coppenholle. ELIA	21/03/2023
Quality manager	María Guadalupe Rodriguez. ATOS	25/04/2023
Project Coordinator	Javier Valiño. ATOS	28/04/2023

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List of Acronyms

Abbreviation / acronym	Description
AI	Artificial Intelligence
API	Application Programming Interface
BDVA	Big Data Value Association
CGMES	Common Grid Model Exchange Standard
CIM-ETSI	Context Information Management. ETSI
CIM-IEC	Common Information Model. IEC 61970, 61968, 62325 series
CSA	Coordination and Support Action
DAIRO	Data, AI and Robotics
DAPS	Dynamic Attribute Provisioning Service
DATA CELLAR	Data hub for the Creation of Energy communities at Local Level and to Advance Research on them
DDI	Data-Driven Innovation
DLT	Distributed Ledger Technology
DoEAP	Digitalisation of the Energy sector Action Plan
DSBA	Data Space Business Alliance
Dx.y	Deliverable number y belonging to WP x
EC	European Commission
EDDIE	European Distributed Data Infrastructure for Energy
ENERSHARE	European commoN EneRgy dataSpace framework enabling data sHaring-driven Across- and beyond- eneRgy sErvices
EU	European Union
HPC	High Performance Computing
IaaS	Infrastructure as a Service
IDS	International Data Spaces Association
IntNET	Interoperability Network for the Energy Transition
IoT	Internet of Things

Abbreviation / acronym	Description
NA	Not Applicable
NGSI	Next Generation Service Interface
PaaS	Platform as a Service
PESTLE	Political, Economic, Social, Technical, Legal, Ethical
SaaS	Software as a Service
SSH	Social Sciences and Humanities
SYNERGIES	Shaping consumer-inclusive data pathwaYs towards the eNERGy transItion, through a reference Energy data Space implementation
UC	Use Case
WG	Working Group
WP	Work Package

Executive Summary

D2.2 “Data Space initiatives/projects in EU and BRIDGE alignment” includes a first assessment of data space initiatives at EU level, identification of use cases specified in sister projects, and monitoring of cross-domain actions. This deliverable implements the methodology defined in D2.1 “Foundations for a holistic iterative methodology”. This strategic vision has been translated operationally into an assessment table template that has been used to assess data space initiatives and sister projects. Four energy data space initiatives have been selected for this first iteration, the four that have rallied a business alliance called DSBA (Data Space Business Alliance) and probably the most influencing ones of the moment in the domain of European data spaces: GAIA-X, IDSA, BDVA/DAIRO and FIWARE. Additionally, OMEGA-X project aims at collaborating with four projects that are funded under the same call: Enershare, Data Cellar, Synergies and EDDIE. For this first iteration, as all these projects have been launched relatively recently, the current assessment produced very preliminary results and will need to be confirmed in the next two iterations. However, this is clear that all four use case families defined in OMEGA-X project find related preoccupations in sister projects that will need collaborative interactions and the monitoring activity reported in this deliverable cannot ignore cross-domain actions held in Int:Net and BRIDGE.

Harmonization of architectural frameworks and assets of the four data space initiatives assessed has not yet been achieved. This situation hinders global interoperability and will impose to OMEGA-X project to adopt an agile development strategy for both the definition of its own framework and the production of its software building blocks.

Semantic interoperability in the energy domain has not been addressed by these four data space initiatives because they were more focussed on semantic interoperability of more generic domains like identity and trust, data management, security and reliability. Recent task forces have been launched by several data space initiatives to tackle semantic interoperability in energy domain and the situation should evolve rapidly.

1 Introduction

1.1 Purpose of the document

The motivation for this document is to collect the results of the monitoring and collaboration activities carried out in the first phase in the OMEGA-X project and reached out to three different communities.

The first concerns Data Space Initiatives and their relative features with a particular focus on their interoperability properties.

Then, the second relates to the so-called Sister Projects, funded under the same call, and thus addressing complementary issues related to dataspaces, in particular potential use cases in the energy domain.

Lastly, the third perspective is interested in cross-domain actions (like the ones supported by Int:Net, and the ones supported by BRIDGE) that intend to organize and manage interactions among several other projects.

This document will be revised and updated yearly. The present document is the result of the first iteration.

1.2 Relation to another OMEGA-X project deliverable

D2.2 refers to the holistic iterative methodology described in D2.1.

1.3 Structure of the document

This document is structured in eight parts.

Part 1 is this introduction.

Part 2 reminds the monitoring methodology defined in D2.1 document and introduces the template that will be used for assessments.

Part 3 provides assessment results of four Dataspace Initiatives and concludes in a discussion about their relative maturity levels.

Part 4 provides assessment results of four Sister Projects and concludes in a discussion about their relative scopes.

Part 5 reports on two cross domain actions.

Part 6 concludes this document.

Part 7 is the reference section.

At the end, annexes are included where relevant background and complementary material.

1.4 Glossary adopted in this document

Please refer to D2.1 Glossary.

2 Application of monitoring methodology

This section begins with a brief reminder of monitoring methodology described in deliverable D2.1 and ends with the template for the assessment tables derived from the methodology and that will be used in the following sections.

2.1 Monitoring methodology

Monitoring activities are structured into five basic pillars of actuation.

- **Interoperability**. To cope with heterogeneity of software solutions and business practices, interoperability is the paramount property to allow sharing and exchange of energy data. Because interoperability is a very generic term that can be applied to several levels of abstraction, this pillar has been refined in five axes.
  - Architecture framework: methods and tools that are used to produce project artefacts.
  - Software / Application Programming Interface (API) interoperability: protocols and interfaces used for exchanging data (also known as syntactic interoperability).
  - Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications: level of conformance to GAIA-X specifications.
  - Semantic interoperability (incl. data models and formats): alignment on common data models based on European standards.
  - Identification of shared cross-projects use cases: use cases showing interactions among several projects.
- **Deployment of cutting-edge technologies**. The energy industry is becoming totally digitalized, which opens up a wider range of prospects provided they are addressed with the appropriate resources. The OMEGA-X consortium will deploy the most recent technologies and look for ways to promote modern energy services.
- **Marketplace and innovative business models**. OMEGA-X's sustainability strategy is based on the provision of services in an accessible manner, the alignment with the Digital Single Market, and the ease of implementation and adoption of the business models associated with it.
- **User involvement and co-creation / societal impact**. OMEGA-X aims to ensure the relevance of its activities and maximize the impact on the community by involving a diverse range of users and actively engaging them in the development and validation of the entire system.
- **Use case family operation**. To simplify management and facilitate tracking and early detection of potential issues, the four use case families will be implemented using a common structure. The pilots will be run in cycles to allow for the inclusion of Social Sciences and Humanities(SSH) methodology and feedback collected in a systematic manner to improve OMEGA-X solutions with each iteration.

2.2 Template for the assessment tables

Based on D2.1 monitoring methodology, this document. D2.2. defines a template to capture in a synthetic way the monitoring activities held in OMEGA-X as proposed hereafter.

After identification of the project (name and type: Data Space Initiative or Sister Project), the way the five pillars are achieved is described.

For convenience, the third pillar has been split into two lines relative respectively to marketplaces and business models.

Also, 'Identification of shared cross-projects use cases ' axe and 'Use case family operation' pillar have been merged in a single criteria 'main business use cases' to report on use cases identified in the project or the initiative assessed.

Lastly, 'Deployment of cutting-edge technologies' pillar has been refined and renamed as 'Supporting tools for deploying Data Spaces' criteria to report on availability of supporting and deployment tools.

Table 1. Template for assessment tables

Project name		
Project type		
Interoperability	Architecture framework	
	Software / API interoperability	
	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	
	Semantic interoperability	
Marketplace		
Innovative business models		
User involvement and co-creation / Societal impact		
Main business use cases		
Supporting tools for deploying Data Spaces		

3 Data Space initiatives monitoring

The following Data Space initiatives are member of the Data Space Business Alliance (DSBA) since September 2021: GAIA-X European Association for Data and Cloud AISBL, the Big Data Value Association (BDVA), FIWARE Foundation, and the International Data Spaces Association (IDSA). Together they represent 1,000+ leading key industry players, associations, research organizations, innovators, and policymakers worldwide. With this cross-industry expertise, resources and know-how, the Alliance drives awareness, evangelizes technology, shapes standards, and enables integration across industries.

The goal of the Data Space Business Alliance is to provide a common view on data spaces including a common technical framework based on the scope of work of the partners and the technical alignment achieved between its members: BDVA/DAIRO, FIWARE Foundation, GAIA-X, IDSA. The DSBA reference document [1] is named “Technical Convergence”, version 1.0.1 and was published in 2022-09-26.

3.1 GAIA-X

GAIA-X aims at creating a federated open data infrastructure based on European values regarding data and cloud sovereignty. The mission of GAIA-X is to design and implement a data sharing architecture that consists of common standards for data sharing, best practices, tools, and governance mechanisms. It also constitutes an EU-anchored federation of cloud infrastructure and data services, to which all 27 EU member states have committed themselves.

Table 2. Assessment of GAIA-X Initiative

Project name		GAIA-X
Project type		Data Space Initiative
Interoperability	Architecture framework	GAIA-X Association has defined its own architecture framework [2] based on planes (trust, management and usage planes) and ecosystems (infrastructure and data ecosystems) as illustrated in Figure 1 . The GAIA-X Architecture document describes the concepts required to realize GAIA-X compliant data and/or infrastructure ecosystems which constitute the GAIA-X Ecosystem. It integrates the Providers, Consumers, and Services essential for this interaction. These Services comprise ensuring identities, implementing trust mechanisms, and providing usage control over data exchange and Compliance without the need for individual agreements. The GAIA-X Architecture Document describes both the static decomposition and dynamic behavior of the GAIA-X core concepts and Federation Services.

Project name		GAIA-X
Interoperability	Software / API interoperability	The GAIA-X Ecosystem includes a huge variety of participants and service Offerings. Therefore, interoperability needs to be ensured on different levels (Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), data resources, and others) by means of Service Composition. Regarding interoperability of data, data exchange in GAIA-X Ecosystem is enabled by a set of Data Exchange Services that are realized by each Participant and can be supported by the Federation [3] .
	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	Full, as GAIA-X Association is producing these specifications.
	Semantic interoperability	GAIA-X Association develops an extensible hierarchy of Schemas [4] [5] that define the terms used in Self-Descriptions and which must be supported by any GAIA-X Catalogue [2] . It is possible to create additional Schemas specific to an application domain, an Ecosystem, Participants in it, or Resources offered by these Participants. A Schema may define terms (classes, their attributes, and their relationships to other classes) in an ontology. If it does, it must also define shapes to validate instances of the ontology against.
Marketplace	GAIA-X Association is not currently providing marketplace requirements.	

Project name	GAIA-X
Innovative business models	GAIA-X Association, through the Energy working group, is working on identifying viable business scenarios to test the application of data spaces. Those business scenarios spin around the following principles: • Accelerate the deployment of low carbon energy solutions • Foster energy efficiency and sector coupling (integration of power, gases, hydrogen across buildings/heating systems, mobility, and industry…) • Enable more flexibility to integrate renewable energy into the European electric system • Accelerate the energy system digitalisation Maintain the European Union's technological sovereignty and global competitiveness in the energy sector [6] . The energy data space is described in a reference document published in April 2021 [7] .
User involvement and co-creation / Societal impact	GAIA-X is not directly working on this social axes. • Nevertheless, there are relevant actions such as the trust plane [8] , which indirectly impact social axes.
Main business use cases	Not Applicable (NA)
Supporting tools for deploying Data Spaces	GAIA-X Association is not pushing for any given technology, but just providing requirements for composing aligned data spaces. Several videos associated to GAIA-X deep dives are available [9] . A GAIA-X repository is available at https://gitlab.com/gaia-x/ where GAIA-X architecture documentation is available [10] with its associated GitLab repository [11] .

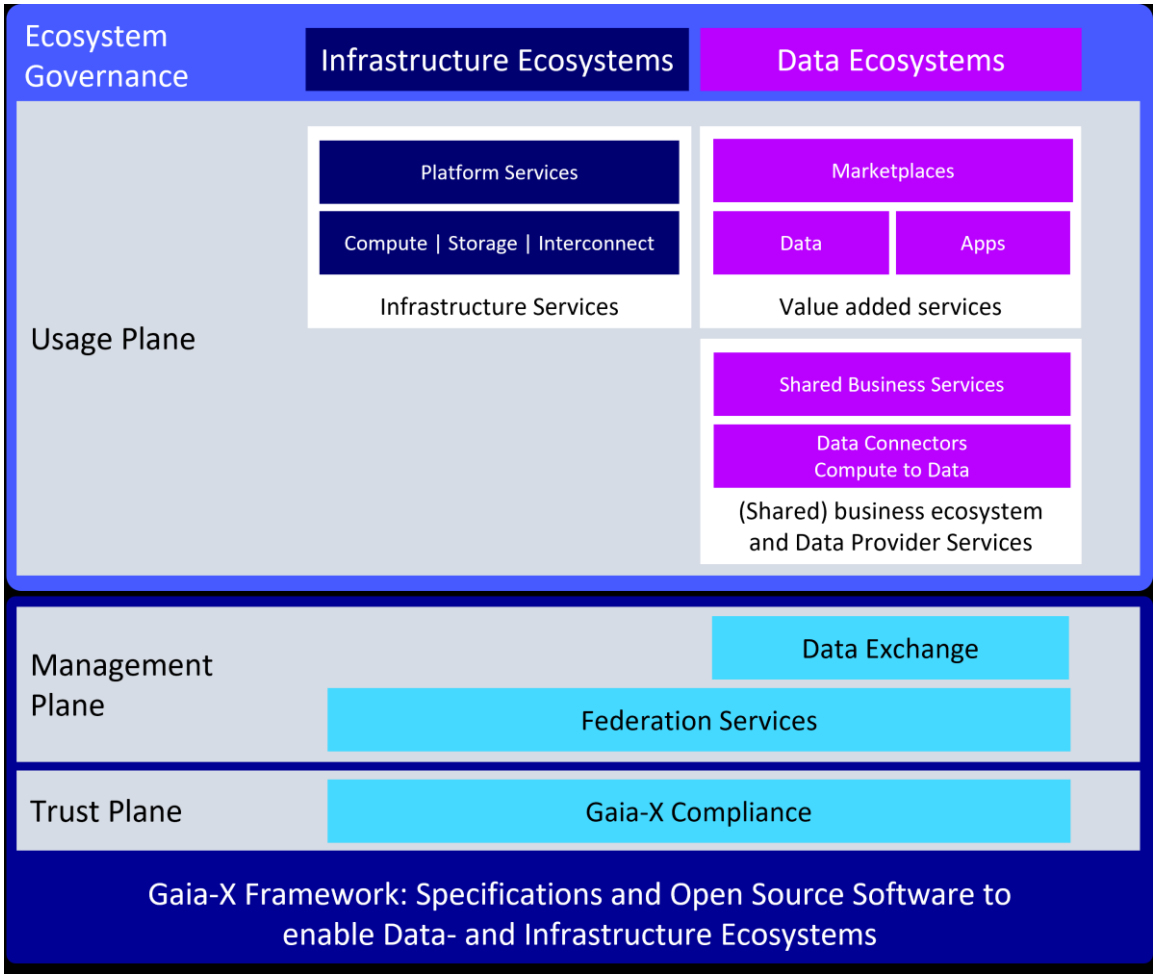

Figure 1. GAIA-X Architecture Framework

3.2 IDSA

IDSA is coalition of more than 130 member companies that share a vision of a world where all companies self-determine usage rules and realize the full value of their data in secure, trusted, equal partnerships; and making that vision a reality. The goal of this association is to define global standard for international Data Spaces (IDS) and interfaces, fostering the related technologies/business models that will drive the data economy of the future across industries. Further information regarding the components described below can be found in the Annex.

Table 3. Assessment of IDSA Initiative

Project name		IDSA
Project type		Data Space Initiative
Interoperability	Architecture framework	Reference Architecture Model for the International Data Spaces (IDS-RAM) [12] with the following design layers: Business, Functional, Information, Process, System. IDS-RAM also analyses three perspectives: Security, Certification and Governance. A federated data architecture is promoted, with emphasis on interoperability, trust and data sovereignty. IDS-RAM is illustrated in Figure 2.
	Software / API interoperability	The IDS Connector is the central technical component for secure and trusted data exchange. The IDS Testbed is a setup with Open Source IDS components which can be used to verify that a component implements the IDS specifications for establishing connections and communication and, thus, can work interoperable with all IDS components in the testbed setup.
	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	There is a working group for GAIA-X and IDSA alignment: IDSA Certification. IDSA certification [13] has two parts: First, you prove that the IDS component you are using is built correctly. Second, you need to make sure your IDS component's operational environment is supporting data sharing according to the requirements and rules. While the certification of your operational environment focuses on security and trust, the component certification also ensures interoperability.

Project name		IDSA
Interoperability	Semantic interoperability	The IDS Information Model [14] . The Information Model primarily aims at the description, publication and discovery of data products and data processing software within the International Data Spaces. A structured, semantic annotation ensures the provision of the most relevant assets, appropriate for a client's task. Once identified, the Information Model enables automated consumption of those offerings via service interface and protocol binding definitions. Next to those core assets, the Information Model further describes essential properties of International Data Spaces entities, its participants, infrastructure components and processes. An IDS Protocol is currently being developed and will be available in future deliverables.
Marketplace		IDS defines the IDS App Store as a secure platform for distributing applications. An IDS App Store consists of a registry for available IDS Apps in this IDS App Store. It also features the capability to search for IDS Apps using different search options. While IDS does not have a Marketplace, it has components, such as the Clearing House, Broker and Vocabulary Hub (described below), that can be part of a marketplace.
Innovative business models		IDSA offers a general business model that includes the following roles: **Data owner and data provider:** The data provider is a device that transfers the owner's data to the data space via the IDS Connector. **Data user and data consumer:** The data consumer is a device that processes data on behalf of the user. IDSA also describes some more technical roles, including the clearing house, broker, app store, identity provider and vocabularies [15]. There are projects [16] that are using the IDSA business role model and perhaps will make the definitions of novel business models per domain.

Project name	IDSA
User involvement and co-creation / Societal impact	IDSA is a charitable non-profit user association. All members have the same rights to use the results [17] . It is an international initiative that involves more than 20 countries. IDSA Rule Book using PESTLE analysis : Political, Economic, Social, Technical, Legal, Ethical.
Main business use cases	NA
Supporting tools for deploying Data Spaces	The IDSA Rule Book [18] defines structures and processes for implementing the IDS-Reference Architecture Model in the real world. The IDSA Knowledge Base [19] breaks down the process of building data spaces into five easy-to-follow steps, guiding the reader from an initial learning phase all the way up to a live and functional data space. Several "YouTube" videos are available, like one for the Rule Book [20] as part of a series of "Tech Talks" regarding the different IDS components. An IDSA GitHub [21] is proposed.

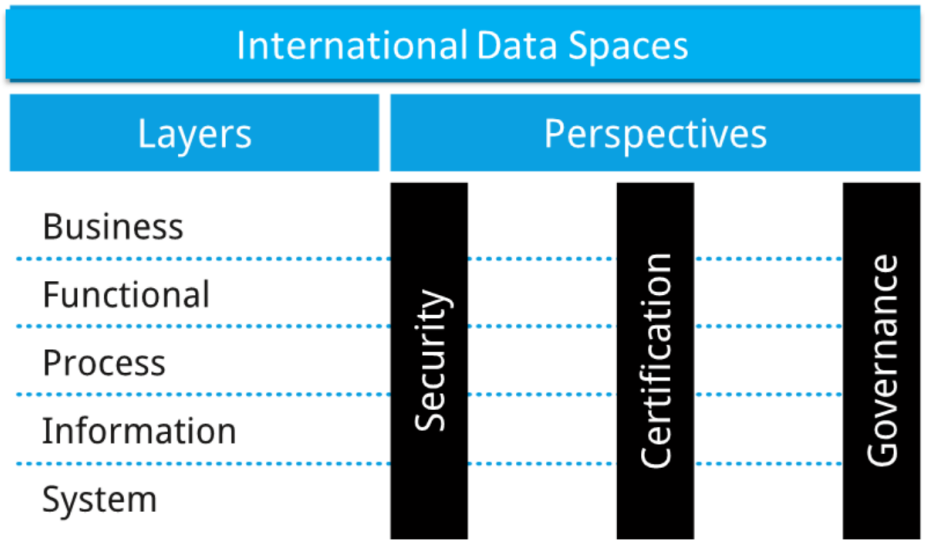

Figure 2. IDSA Reference Architecture Model

3.3 BDVA/DAIRO

In 2020 and taking into account the end of the 2014-2020 Multi Annual Financial Framework and the advent of the post 2020 European Commission's programmes (i.e. Horizon Europe and Digital Europe), BDVA members decided to strengthen the Association by giving it a new

mandate, a new name and by expanding its scope and breadth of activities. In 2021, BDVA thus becomes DAIRO. DAIRO stands for Data, AI and Robotics (DAIRO). This new name testifies the ambition of the Association to closely collaborate with other communities in order to jointly engage at the intersection of the key disciplines of Data, Artificial Intelligence (AI) and Robotics.

Table 4. Assessment of BDVA/DAIRO Initiative

Project name		BDVA/DAIRO
Project type		Data Space Initiative
Interoperability	Architecture framework	The BDV Reference Model is structured into horizontal and vertical concerns. as illustrated in Figure 3. • **Horizontal** concerns cover specific aspects along the data processing chain, starting with data collection and ingestion, and extending to data-visualization. It should be noted that the horizontal concerns do not imply a layered architecture. As an example, data-visualization may be applied directly to collected data (the data management aspect) without the need for data processing and analytics. • **Vertical** concerns address cross-cutting issues, which may affect all the horizontal concerns. In addition, vertical concerns may also involve non-technical aspects. It should be noted **that the BDV Reference Model has no ambition to serve as a technical reference structure**. However, the BDV Reference Model is compatible with such reference architectures, most notably the emerging **ISO JTC1 WG9 Big Data Reference Architecture.**
	Software/API interoperability	no
	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	yes. member of DSBA
	Semantic interoperability	Will publish a paper on semantic interoperability as part of TF10 in early 2023.

Project name	BDVA/DAIRO
Marketplace	i-Spaces / EUHubs4Data: Catalogue of federated services, datasets and training offered by the i-Spaces.
Innovative business models	Data-Driven Innovation (DDI) Framework systematically addresses the challenges of identifying and exploring data-driven innovations. It guides start-ups, entrepreneurs and established companies alike in scoping promising data business opportunities by analysing both the dynamics of supply and demand. (https://ddi-canvas.com/)
User involvement and co-creation / Societal impact	i-Spaces / EUHubs4Data: cross-sectoral and cross-organisational innovation hubs that bring together data sources, AI technologies, competences and all the technical and non-technical aspects needed to allow SMEs and start-ups to get their data-driven and AI-related services, products and applications quickly tested, piloted, and exploited Task Force 9: Skills. Task Force 9 aims to provide a framework for skill recognition in the Big Data ecosystem in Europe.
Main business use cases	i-Spaces/EUHubs4Data (European federation of data-driven digital innovation hubs) : sharing of information and good practices, organization of joint events, and shaping the strategy of the collaboration. With the objective of serving as a reference to the establishment of the Common European Data Spaces, the federation is initially composed of 12 Digital Innovation Hubs, covering 10 countries and 12 different regions.
Supporting tools for deploying Data Spaces	Focused on Data, AI, Robotics and HPC. BDVA has recorded several webinars concerning Data Spaces [22] .

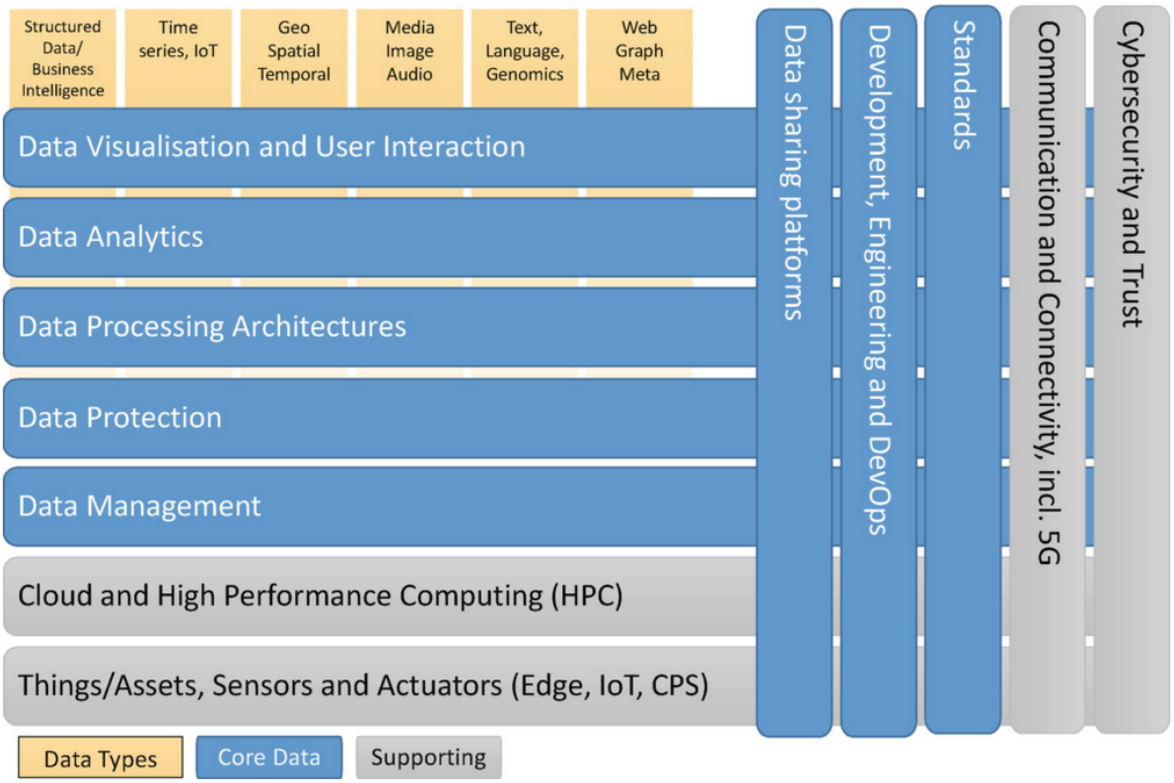

Figure 3. Big Data Value Reference Model

3.4 FIWARE

FIWARE Foundation is a non-profit organisation that drives the definition and encourages the adoption of open standards. based on Open Source technologies, reference architectures and over 800 Smart Data Models. to ease the development of portable and interoperable smart solutions in a faster, easier and affordable way, avoiding vendor lock-in scenarios. Founded in 2016, the foundation has Atos, Engineering, NEC, Red Hat, Telefónica and Trigyn Technologies among its 430+ members.

Together with its members and partners, FIWARE Foundation drives the definition. and the Open Source implementation. of key open standards that enable the development of portable and interoperable smart solutions in a faster, easier and affordable way, avoiding vendor lock-in scenarios, whilst also nurturing FIWARE as a sustainable and innovation-driven business ecosystem.

FIWARE's iHubs focuses on building communities that will, in turn, enable local digital businesses to thrive not only at a regional but on a global level. They support companies, cities, and developers in their innovation and digitalisation journey by offering easy access to Open Source technologies, business development support, and community building.

Table 5. Assessment of FIWARE Initiative

Project name		FIWARE
Project type		Data Space Initiative
Interoperability	Architecture framework	The Reference Architecture of Smart Energy Management Systems "Powered by FIWARE" relies on a "System of Systems" vision as illustrated in Figure 4 [23] . The existence of a context information management layer breaks the silos of information associated with the several vertical smart solutions, information systems and connected devices, enabling an overall management of an Energy ecosystem.
	Software / API interoperability	Two APIS to exchange context information: • FIWARE NGSI (Next Generation Service Interface) V2 for simple data • NGSI-LD [24] (ETSI standard) for linked data Several communication protocols: • IDAS IoT Agents connects to sensors, handling multiple IoT protocols (MQTT, CoAP/OMA-LWM2M, OneM2M,...). Alternative IoT platforms can be used for this purpose. • ROS-2 robots are interfaced using Fast RTPS, adopted as default communication middleware in ROS-2.
	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	Not known for now.
	Semantic interoperability	The Smart Data Models Initiative [25] is a joint collaboration initiative of The FIWARE Foundation, TM Forum, IUDX and OASC to support the adoption of a reference architecture and compatible common data models that underpin a digital market of interoperable and replicable smart solutions in multiple sectors, starting with Smart Cities. A smart data model includes three elements: The schema, or technical representation of the model defining the technical data types and structure, the specification of a written document for human readers, and the examples of the payloads for NGSIv2 and NGSI-LD versions. Current domains: SMART CITIES, SMART ENVIRONMENT, Cross Sector, SMART AGRIFOOD, SMART SENSORING, SMART ROBOTICS, SMART WATER, Smart Aeronautics, SMART HEALTH, SMART ENERGY, Smart Destination, SMART MANUFACTURING. Smart Energy domain: Battery, Consumption, Energy, EnergyCIM, GreenEnergy, Weather.

Project name	FIWARE
Marketplace	The Marketplace is a global one-stop shop that gives access to a wide range of Powered by FIWARE solutions and platforms, FIWARE-ready technologies, as well as related training, coaching, consultancy, integration and services [26] . The Marketplace offers everyone in the FIWARE Community the platform to increase visibility and attract target customers or potential investors and partners. **POWERED BY FIWARE** Smart Solutions rely on FIWARE standards (using NGSI open standard) to manage context information at a large scale. They use the FIWARE technologies to gather and process context information coming from different and highly distributed sources. FIWARE platform service providers offer FIWARE as a Service on private and public clouds. Also, platform service providers can deploy FIWARE platform instances on premises for their customers. **FIWARE-READY TECHNOLOGIES** FIWARE-ready IoT devices come with easy-to-install drivers and instructions, accessible to end applications using the FIWARE NGSI standard. FIWARE-ready software enablers are base platform technologies, which can easily be integrated with FIWARE. This extends the basic capabilities of the platform with advanced added-value features. **FIWARE SUPPORT SERVICES** Online training material is available on the FIWARE Academy but many partners are offering tailored training and coaching services. Finding the right experts offering consultancy, integration or technical support services is crucial for many projects. The FIWARE Marketplace is helping to serve this need.
Innovative business models	Several publications introduce the capabilities of the FIWARE platform, which is transitioning from a research to a commercial level. Some papers are based on real-world use cases (global IoT market, analytics in smart cities, and IoT augmented autonomous driving) and their requirements that are addressed with the usage of FIWARE.

Project name	FIWARE
User involvement and co-creation / Societal impact	Publication exists on how FIWARE can lead to agile development of smart mobility services that can minimize traffic congestion, fuel consumption, and CO2 emissions. FIWARE has also been used in the Smart City domain.
Main business use cases	In addition to NGSI-LD, ETSI has published a document [27] that discusses the concepts which are foundational for Cross-Cutting Context Information Management (C3IM) and their application to a selection of Use Cases from the domain of Smart Cities and, in future versions, from the domains of Smart Agrifood and Smart Industry. These areas of application, together with the general area of Internet of Things (IoT) technology and services, are expected to especially benefit from usage of cross-cutting (cross domain) context information, and from a set of specifications for the APIs supporting C3IM. Smart City Cross-cutting Use Cases • UC1: Sharing information between parking management systems and traffic management applications • UC2: Smart Street Lighting • UC3: Traffic Management & Pricing based on Air Quality, Congestion and other KPIs • UC4: Crowd Monitoring and Emergency Response • UC5: Management of Optical Fibre Network Deployment
Supporting tools for deploying Data Spaces	Recorded Webinars are available [28] .

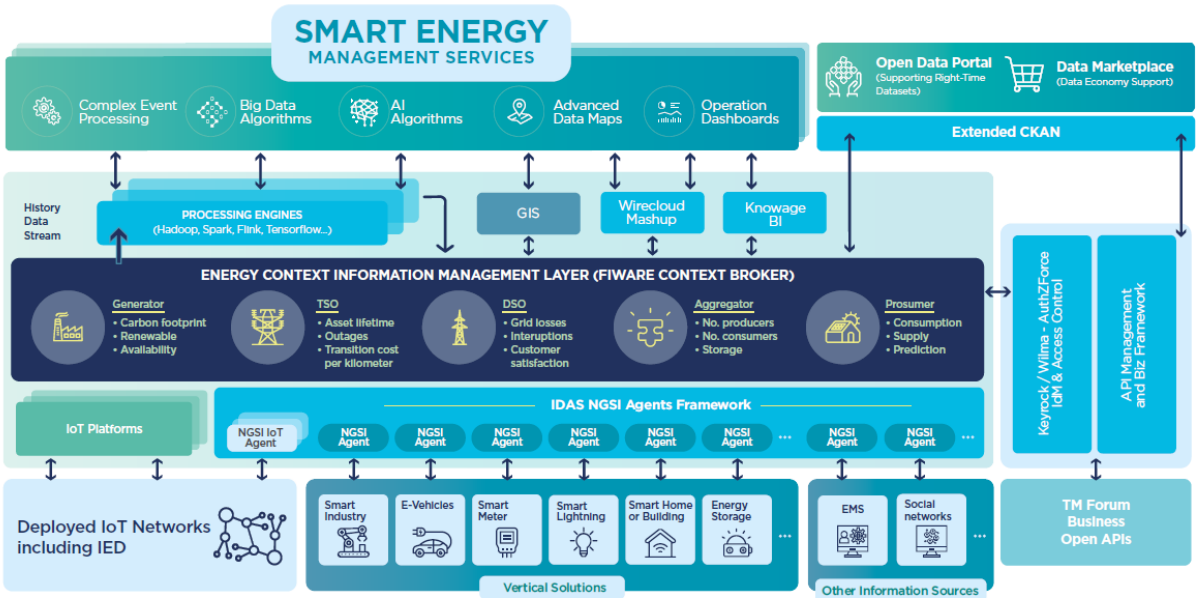

Figure 4. FIWARE Reference Architecture

3.5 Discussion on Data Space Initiatives

Data space initiatives were assessed by following a template structure that considers attributes such as relevant project references, its interoperability, the deployment of cutting-edge technologies, the availability of a marketplace and innovative business models, its societal impact through user involvement or co-creation, and the use case family operation. The template and its components were explained by the speakers in detail.

The data space initiatives under assessment are the following: GAIA-X, IDSA, FIWARE, and BDVA/DAIRO. The OMEGA-X project proposal states that there is a commitment to be aligned among these initiatives which are part of the DSBA (Data Space Business Alliance). Thus, all four data space initiatives should progressively align on a common framework and on main software building blocks at the technology level.

The results of all four assessments under concern of the template, conducted by different members of Work Package 2 (WP2), as well as their synthesis and comparison are presented in the previous sections. The following provides a summary of that. At this point, OMEGA-X needs to practically engage with the DSBA members towards closing the design phase and, therefore, produce a first working version of the architecture. This way, the following conclusions and way forward would summarize this need, concentrating of the identified pieces to be used at each initiative level and the plan for starting the development phase based on that.

- **GAIA-X**: The alignment with GAIA-X is highly important since it defines the project's whole architecture framework, which is especially relevant on the implementation level. Looking at the technical convergence document issued by the DSBA, it seems clear that GAIA-X is a prime contributor on the identity, compliance, registry and trust areas.
  - OMEGA-X partners will therefore focus their attention in engaging with GAIA-X specially on those topics, looking at the reference implementations, liaising with GAIA-X experts on

the topics and participating in GAIA-X meetings to present the outcomes of the implementations achieved.

  - In addition, there are other areas were OMEGA-X think GAIA-X could provide solid baseline, although some other sources are also being studied. This applies for instance to the Federated Catalog, Portal and Data Exchange services. As in the previous case, OMEGA-X members will engage with GAIA-X on those topics, seeking for clarification and also, if that is the outcome of the analysis, implementing the reference modules.

- **IDSA**: IDSA is also a prime reference in OMEGA-X as per the architecture definition and reference implementation reuse. Assessments showed that for IDSA there is a marketplace available with the IDS App Store. IDSA is also really active at connector level, offering a suite of IDSA certified modules ready to be deployed, also including a testbed where those connectors can interact with other architectural components such as Dynamic Attribute Provisioning Service (DAPS) or the Broker.
  - OMEGA-X will focus on the integration of an IDSA (and hopefully also GAIA-X) certified connector for managing the data exchanges and federation. The App Store will be also embedded in the marketplace activities for the project. Therefore, those items are marked in the agenda for liaising with IDSA during this next cycle. As in for GAIA-X, this will be done by looking at the reference implementations, liaising with IDSA experts on the topics and participating in IDSA meetings to present the outcomes of the implementations achieved.As other technical implementations and references to be checked, OMEGA-X has flagged the Vocabulary, Broker and Clearing House as potential modules to reuse. In this case, those should be compared and studied in detail including also their counterparts in GAIA-X, to determine the best approach. This way, the engagement expected with IDSA extends also to these items.
- **FIWARE**: Alignment with FIWARE in OMEGA-X is especially relevant for the federated infrastructure part. The IaaS/SaaS vertical platform OMEGA-X plans to develop as complement to the already existing data gathering solutions in the project will be based on FIWARE technology and components.
  - Additionally, FIWARE seems to be positioned, as per the technical convergence document of DSBA, also as marketplace provider. There are some reference implementations regarding this available.
  - This way, the agenda for the following cycle will be exploring both lines of work, liaising with FIWARE experts, especially in the framework of the DSBA, to explore the reusability of such implementations in OMEGA-X.
- **BDVA/DAIRO**: The initiative takes a technology surveillance role and is less focused on architecture frameworks or API interoperability, even though there are efforts regarding a semantic interoperability. BDVA is more focused on large ecosystem developments, e.g. it is connected to the European Commission, and rather values big data businesses. It provides more a catalogue than a marketplace. Thus, OMEGA-X could benefit from use cases, technical contributions, or own data and service marketplaces.
  - In summary, BDVA/DAIRO seems to be not offering any potential reusable technologies outside the federated data platforms. The effort will be, thus, focused on that part, and keeping an eye on how to decide to fit also in the technical convergence activities of the DSBA.

A synthesis and comparison of data space initiatives assessments unveils a key point in interoperability. Even though there is a general openness for further similar initiatives, the consideration of which is foreseen, it is also a question of time.

The following table provides a recap for the assessment of the four Data Space Initiatives presented in Section 3.

Cells highlighted in **green** means that those topics will be pushed forward on the plan for OMEGA-X to liaise with the correspondent initiative during the development phase, to make sure we are aligned and also potentially present early results. Cells in **orange** indicate that, for those topics, the initiatives have shown interest and are starting to produce some potentially aligned material, but, at the time this report is written, there is no concrete material to follow up on. Therefore, the topic will be kept on the watch lists for the initiative but with no concrete actions to engage planned. Finally, **red** cells are for topics on initiatives that have been detected as not relevant for them and, therefore, there is no point on discussing those with them in the next cycle.

Table 6. Assessment of Data Space Initiatives

Project name		GAIA-X	IDSA	BDVA/DAIRO	FIWARE
Interoperability	Architecture framework				
	Software / API interoperability				
	Alignment on GAIA-X				
	Semantic interoperability				
	Shared cross-projects use cases				
Deployment of cutting-edge technologies					
Marketplace					
Innovative business models					
User involvement and co-creation / Societal impact					
Use case family operation					

Last but not least, OMEGA-X partners have been following these initiatives closely, not just analysing the documentation but also interacting on regular events and meetings with them. The consortium plans to keep doing the same, with expected increase (especially regarding technical events) for the following cycle.

The list of attended events during the first year (May 2022. April 2023) is detailed below:

- GAIA-X (past and future GAIA-X related events accessible at https://gaia-x.eu/events/)
  - 2023/02/01 Energy Data Space of GAIA-X Steering Committee
- IDSA (past and future GAIA-X related events accessible at https://internationaldataspaces.org/events/)
  - IDSA rulebook overview and how to use it session recording
  - Dataspace Protocol Preview
    - Information Session on March 9th, 2023, 9 to 12 CET.
    - Coding Session on March 9th 13 to 16 CET.
  - Data Spaces Symposium & Deep-Dive Day. The Hague March 21-23
- FIWARE (past and future FIWARE related events accessible at https://www.fiware.org/events/)
  - September 14, 2022. September 15, 2022, FIWARE Global Summit. Leading the Digital Transformation
    - Data Spaces World Café
    - Towards an Energy Data Space Session
    - Smart Energy Session
  - November 10, 2022, EDIC and Data Spaces event
  - November 15, 2022. November 17, 2022, Smart City Expo World Congress 2022
  - 2023 February 21. FIWARE Community Meeting
- BDVA/DAIRO (past and future FIWARE related events accessible at https://www.bdva.eu/events)
  - 2022 Annual General Assembly.

4 Sister Projects monitoring

The following four projects are associated to program HORIZON-CL5-2021-D3-01-01 [29] , which wants to establish the grounds for a common European energy data space by developing, validating and demonstrating an Energy Data Space that enables access to and use of energy data. In the following paragraphs, each OMEGA-X sister projects is assessed, with a focus on their Use Cases description. The objective is to identify common Use Case families between the sister projects and OMEGA-X ones and to prepare, building blocks identification (T2.4).

4.1 ENERSHARE

The ongoing energy system digitization is making available an enormous amount of data, paving the way for data sharing-enabled cross-value chain services, which may contribute to system-level increased efficiency and hence facilitate the energy transition. However data sharing in the energy sector is lagging behind, this is mainly due to a lack of trust, privacy breaches risk and business models immaturity. In that respect ENERSHARE will:

a. deliver a Reference Architecture for a European Energy Data Space, which hybridizes SGAM with IDSA and GAIA-X architectures, by bringing the data value chain perspective into the energy one.
b. evolve interoperability, trust, data value and governance building blocks to TRL 6-7 IDSA-compliant ones, adapt them to energy sector, and deploy:
   - across-energy and cross-sector data enhancement technology enablers and standardizable interfaces and open APIs. This will be enabled by leveraging on open Standards (e.g. ETSI Context Broker) and ontologies (e.g. SAREF)
   - trust-related connectors, to ensure privacy, confidentiality, cybersecurity-preserving trust, sovereignty, and full control of data .
   - blockchain/Smart contract-enriched marketplace for data versus energy assets/services coordination, sharing, exchange, and beyond financial compensation.
   - cross-value chain value-added services and Digital Twins, by leveraging on privacy-preserving federated learning.
c. integrate and deploy technology components within a Reference Implementation of a European Energy Data Space, which will be demonstrated along 7 pilots and 11 intra-electricity, intra-energy and beyond energy use cases
d. co-design SSH-based consumer-centric business models for energy data sharing enabling data beyond-financial value creation and spreading along value chain
e. prepare the ground for the European Energy Data Space setup, through alignment with EU-level relevant initiatives (GAIA-X, IDSA, BDVA, ETIP SNET, BRIDGE), contributing to Data Space standardization and boosting a level playing field for data sharing.

The official kick-off of ENERSHARE was July 2022. The following table assessment provides a summary of the status of the project as of March 2023. The assessment will be refined in future versions of this report.

Table 7. Assessment of Enershare project

Project name		Enershare
Project type		Sister Project https://enershare.eu/ https://cordis.europa.eu/project/id/101069831
Interoperability	Architecture framework	Enershare is currently defining a Data-Driven Reference Architecture for the energy domain, which is compliant with FIWARE, IDSA and GAIA-X. Both FIWARE and IDSA are part of the ENERSHARE consortium and will act as a link with GAIA-X through the DSSC (Data Spaces Support Centre). Alignment with other initiatives such as ETIP-SNET and BRIDGE are made to further increase efforts towards data space standardization and eventually boosting a level playing field for data sharing.
	Software / API interoperability	Enershare will develop cross-sector data enhancement technology enablers, standardizable interfaces and open APIs leveraging Open Standards (e.g. ETSI Context Broker). Therefore they will use NGSI-LD, an information model and API for publishing, querying and subscribing to context information.
	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	Although it has not been decided yet, it is likely that Enershare will use the TRUE (TRUsted Engineering) Connector or an extension of it for sovereign data exchange. As of March 2023, according to public information, the TRUE connector is not aligned with GAIA-X Trust and Labelling Frameworks. Therefore, if ENERSHARE decides to use this connector, the TRUE connector will have to extend its use to make it GAIA-X compatible.
	Semantic interoperability	Enershare will develop a common semantic data model by leveraging the bottom-up approach developed in PLATOON project by starting from use cases and reusing and extending existing open-source semantic ontologies such as SAREF, SEAS, OntoWind, SEEDMOON [30] (SEmantic Data Models Of Nergy produced as a result of PLATOON project) etc.

Project name	Enershare
Marketplace	Enershare will create a marketplace based on blockchain and Smart Contracts with the aim of improving mutual trust amongst the actors of the ecosystem and increasing the security of the shared data. It also enables a compensation system (even non-monetary) of assets and resources related to data (e.g., datasets, algorithms, models) with energy assets and services (e.g., maintenance of heating system, surplus transfer of locally self-produced energy).
Innovative business models	Enershare will define Innovative user-centric business models for Energy data sharing compensation beyond pure financial value (monetisation) and spreading along the value chain.
User involvement and co-creation / Societal impact	Enershare will define a co-designed SSH-based consumer centric approach.
Main business use cases	7 demos in 7 countries including some shared areas with OMEGA-X: • Local Energy communities: Multi-energy vector (electricity and heat) planning in Italy. • Electromobility: Cross-value chain smart building/smart mobility services for LEC in Portugal. • Flexibility:Green Production, Flexible consumption and storage capacity. • Renewables: However it is mainly focused on Wind Energy while OMEGA-X focuses on Solar. Main use case families: • Wind farm • Smart buildings/mobility/smart grid • Heat geo-based planning • Green hydrogen planning • Community-centered services • Renewable/flexibility/storage • Renovation
Supporting tools for deploying Data Spaces	Enershare will develop cross-value chain value added services and hybrid digital Twins considering different privacy-preserving techniques such as federated learning.

4.2 DATA CELLAR

DATA CELLAR will be a data hub for the Creation of Energy communities at Local Level and to Advance Research on them.

DATA CELLAR aims to create a federated energy dataspace that will support the creation, development and management of LECs in EU. The data space population will be facilitated via an innovative rewarded private metering approach, with a focus on an easy onboarding and interaction, guaranteeing a smooth integration with other EU energy data spaces, whilst providing to LEC stakeholders services and tools for developing their activities.

Over its 42 months of duration, the project will seek to achieve five main objectives: 1) development, validation and demonstration of a dynamic data hub ensuring continuously updated, reliable and credible data; 2) implement privacy and cybersecurity-by-design measures according to GDPR & national data handling regulations and security standards; 3) provide access to AI models and data-driven energy services by making use of the stored and exchanged data, supporting the energy transition; 4) create and sustain a highly engaged data sharing ecosystem of European Commission (EC) data providers through a.open Marketplace based on Distributed Ledger Technology (DLT); 5) evaluate DATA CELLAR novel business models upon real Energy Community use cases and collaboration with other relevant EU on-going initiatives participating in BRIDGE to facilitate interoperability testing and demonstration.

Data Cellar Strategic Priorities are:

- Compliance with IDS/GAIA-X
  - Full compliance vs Hybrid solutions (legacy systems)
- Interoperability
  - Data Model (IDSA information model, FIWARE smart data model for energy domain)
  - Software implementation (IDS connector)
- Digital Economy. Valorisation of datasets & AI/ML models (DLT enabled Marketplace)
  - Common ground for synergies of DLT use (e.g., tokenization, identity provision, data provenance, data tracing/notarization)

The official kick-off of DATA CELLAR took place in June 2022. The following table assessment provides a summary of the status of the project as of March 2023. Please consider that more input will be provided in future versions of this report.

Table 8. Assessment of Data Cellar project

Project name		Data Cellar
Project type		Sister Project https://datacellarproject.eu/ https://cordis.europa.eu/project/id/101069694/fr
Interoperability	Architecture framework	DATA CELLAR will develop an Energy Data Space. At the moment the work on defining the requirements is ongoing, the architecture which is to be developed will have to be GAIA-X and IDSA compliant.
	Software / API interoperability	DATA CELLAR is required to be interoperable with sister projects.
	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	DATA CELLAR is planning to be aligned on this.
	Semantic interoperability	DATA CELLAR work on ontologies is still ongoing, the project is currently investigating the IDSA information model, FIWARE smart data model and SAREF for energy domain.
Marketplace		Data marketplace. The Marketplace will allow DATA CELLAR to offer its services using several business models (subscription, free to use, etc.) as defined by the DATA CELLAR consortium. It will be a decentralized and open marketplace powered by the corresponding DLT-driven token remuneration scheme.
Innovative business models		DATA CELLAR will create innovative business models for: a. valorisation of the DATA CELLAR and engagement of users via different business models (temporal subscriptions, token market etc.); b. attract new data providers and guarantee them a reward; c. define a business model for those who manage the platform also for “extra-energy” usage of the data; **d.** guarantee a “free-to-use” version of DATA CELLAR without relevant regulatory implications.

Project name	Data Cellar
User involvement and co-creation / Societal impact	Yes: ECs involvement. DATA CELLAR will facilitate consumer involvement and energy communities' participation into new energy markets for flexibility by providing data models and quantification mechanisms for demand-response and storage control. Involvement of relevant knowledge actors including citizens, civil society and end users in the co-creation of R&I agendas and contents.
Use case family operation	There are 9 demos in 7 different countries which represent different Energy communities at different level of maturity both in terms of status of the energy community (entry-level, early-stage level, pre-implementation level, on-going) and availability of data (poor, good, high). The Validation Cases represents a wide range of possible energy communities that could be found around Europe: rural, urban, industrial, PV, EV and are managed by different stakeholders: DSO, cooperatives, energy agencies as well as other types of stakeholders active in the clean energy field such as charging point managers or flexibility market operators Use Case families are explained below and grouped per beneficiary

Project name	Data Cellar
Supporting tools for deploying Data Spaces	DATA CELLAR will deliver three main services that rely on Data Space, pre-trained AI models & libraries and DLT layer main core modules: i) A Decentralized and Open Marketplace where end users, both private citizens and energy operators, can be remunerated for the provision of energy datasets, direct streams of energy data or AI models and algorithms. This feature will enable a new token-based economy where the provision of data and pre-trained models can be incentivized and fairly remunerated through a reward-based mechanism. In addition, the transactions for provisioning or supplying data and models will be notarized through the DLT providing transparency and a consensus on the shared ledger state among stakeholders. In terms of data provenance and validation, the DLT solution will provide a tamper-proof transaction history along with a proof-of-origin for data and models. ii) A holistic Decision Support System (DSS) for energy communities' development to support energy utilities, DSOs, and technology providers to assess different scenarios: the impact of technology, a strategy on energy communities, or energy networks connecting different buildings within the same EC. The tool will support EC users in the assessment of optimal choices, flexibility services, and financial analysis. Grid operators will be able to assess the optimal location of resources to improve the operation of the distribution grid. iii) A Data Analytics platform to guide energy data analysts in the design of data pipelines leveraging on the ML and DL models acquired from the DATA CELLAR marketplace. These capabilities will be delivered through a user-friendly HMI that will allow the user to drag and connect models and data to extract meaningful and valuable insights from energy datasets.

DATA CELLAR aims to establish **Data** hub for the **C**reation of **E**nergy communities at **L**ocal **L**evel and to **A**dvance **R**esearch on them. Data Cellar has 9 Validation cases with 2 Data Providers. Its main objectives are:

- Development, validation and demonstration of a dynamic data hub
- DLT-based open marketplace and novel business models
- Deliver data-driven energy services to support the energy transition
- Implement privacy and cybersecurity-by-design

Data Cellar defined class of use cases per beneficiary:

Class of Use Cases focused on the Scientific Community & Data Analytics Developers:

- Access to Data (Anonymized/Aggregated) via a decentralized and open Marketplace.
- Access to AI/ML libraries via a decentralized and open Marketplace.
- Development of AI/ML libraries via a Data Analytics Tool
- Provision of developed libraries to a decentralized and open Marketplace.

Class of Use Cases focused on Energy Community Managers:

- Access to data analysis by acquiring AI/ML libraries via a decentralized and open Marketplace.
- Access to Decision Support System services for:
  - Optimal RES sizing
  - Flexibility forecasting
  - Resources' optimal location
  - Management of resources
  - Building energy assessment/Life cycle cost & life cycle

Class of Use Cases focused on Energy Consumers/Prosumers/LEC members:

- Provision of datasets (Anonymized/Aggregated) to a decentralized and open Marketplace.
- Access to data analysis by acquiring AI/ML libraries via a decentralized and open Marketplace.
- Access to Decision Support System services for:
  - Optimal RES sizing
  - Flexibility forecasting
  - Building energy assessment/Life cycle cost

Class of Use Cases focused on Electric Mobility Operators:

- Access to electromobility and other data via a decentralized and open Marketplace to better understand, develop, and manage local energy communities.

Class of Use Cases focused on Flexibility Market Operators:

- Access to data via a decentralized and open Marketplace to verify flexibility activations.

4.3 SYNERGIES

Shaping consumer-inclusive data pathwaYs towards the eNERGy transItion, through a reference Energy data Space implementation (SYNERGIES).

SYNERGIES introduces a reference Energy Data Space Implementation that will attempt to unleash the data-driven innovation and sharing potential across the energy data value chain by leveraging on data and intelligence coming from diverse energy actors (prioritizing on consumers and introducing them as data owners/ providers) and coupled sectors (buildings, mobility) and effectively making them reachable and widely accessible.

In turn, it will facilitate the transition from siloed data management approaches to collaborative ones which promote the creation of a data and intelligence ecosystem around energy (and other types of) data and enable the realization of data (intelligence)-driven innovative energy services that

(i) value the flexibility capacity of consumers in optimizing energy networks' operation, maximizing RES integration and self-consumption at different levels of the system (community, building),
(ii) evidently support network operators in optimally monitoring, operating, maintaining and planning their assets and coordinating between each other (TSO-DSO collaboration) for enhancing system resilience,
(iii) create an inclusive pathway towards the energy transition, through consumer empowerment, awareness, and informed involvement in flexibility market transactions,
(iv) step on real data streams and intelligence to deliver personalized and automated features to increase prosumer acceptance and remove intrusiveness,
(v) facilitate the establishment of sustainable LECs by enhancing their role with Aggregator and BSP functions,
(vi) establish solid grounds for the creation of a new economy around energy data produced and shared across a complex value chain, in a secure, trustful, fair, and acceptable manner.

SYNERGIES will be extensively validated in 3 large-scale demonstration sites in Greece, Spain and Denmark involving complete value chains, diverse data sources, heterogeneous energy systems/assets and spanning different socio-economic characteristics.

Table 9. Assessment of Synergies project

Project name		Synergies
Project type		Sister Project https://energydataspaces.eu/ https://cordis.europa.eu/project/id/101069839
Interoperability	Architecture framework	Synergies plans to set up an Energy Data Space, but there is no mention on the public documentation about the references to be used for this. It is very likely that they will end up aligning as well with GAIA-X and IDSA, but this is something to be discussed in detail with them. Synergies comes from a previous Energy/Big Data project named Synergy, which already worked on deploying a data platform solution focused on flexibility, so it is very likely that they also plan to evolve this pre-existing framework.

Project name		Synergies
interoperability	Software / API interoperability	Synergies include as an objective [31] "Deliver a reference implementation for an Energy Data Space, properly integrating cutting-edge big-data management technologies, enabling interoperable communication and exchange with heterogeneous data sources and platforms". As a sister project, Synergies is also required by contract to foster interoperability, so they should as well deploy open APIs.
	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	No information at this point. It is assumed no alignment is made so far.
	Semantic interoperability	Synergies has not yet published any information about the ontologies they plan to use or they plan for semantic interoperability. Nevertheless, it is very likely that they will reuse (at least partially) the Common Information Model developed as part of Synergy [32] . On that model, the following standards are mapped: IEC 61850. 61968. 61970. 62056. 62325. 62361, OpenADR, USEF, SAREF. SAREF4ENER. SAREF4BLDG, IFC, SSN and CCTS.
Marketplace		Synergies plans to develop and test an "Energy Services Marketplace". It is very likely that this marketplace will be aligned with Synergy one. If that is the case, it will not be aligned with the DSBA architecture, so there is a need to closely monitor this towards alignment.

Project name	Synergies
Innovative business models	Synergies last cycle (out of 4) is devoted to "Business innovation planning". There, they expect to detail a sales strategy, a continuous market/competition analysis, a marketing mix, an operational plan, a business unit exit strategy and financial projections for all their innovative business models. For the moment, the information available on this suggests that they will be working on the following areas [33] : • value the flexibility capacity of the demand side (prosumers) in optimizing energy networks' operation and/ or maximizing RES integration and self-consumption at different levels of the system (community, building); • evidently support network operators in optimally monitoring, operating, maintaining and planning their infrastructures and coordinating between each other (TSO-DSO collaborative management) for enhancing system resilience; • create an inclusive pathway towards the energy transition, through prosumer empowerment, awareness and informed involvement in energy/ flexibility market transactions; • facilitate the establishment of sustainable LECs by enhancing their role with aggregator/ BSP functions and promoting attractive business cases for increasing their viability; • establish the grounds for the creation of a new economy around energy data produced and shared across a complex value chain, in a secure, trustful, and fair manner.
User involvement and co-creation / Societal impact	There is no information available on this still. Nevertheless, as a sister project, SSH is expected to be tackled in the project as suggested by the European Commission in the call for proposals.
Main business use cases	All three Synergies' use cases are devoted to studying Local Energy Communities and their approach to flexibility, including multiple vectors. They are, therefore, very linked to the OMEGA-X use case family on Local Energy Communities, and also partially with the OMEGA-X flexibility use case family. Explained in detail below.

Project name	Synergies
Supporting tools for deploying Data Spaces	Synergies' objectives [34] state the following aims with respect to technology: "Step on real data and intelligence extracted by them to deliver personalized energy services and automated features to increase prosumer acceptance and remove intrusiveness." "Deliver a bundle of data-driven and intelligence-enabled digital solutions and energy services to effectively contribute to energy system decarbonization and consumer empowerment."

SYNERGIES brings forward a reference Energy Data Space Implementation that unleashes data-driven innovation and promotes the creation of an inclusive ecosystem of stakeholders across the energy data value chain by leveraging on an intelligence-enabled digital solution.

The SYNERGIES project will develop 8 demo cases in 3 demo sites [35] :

- Greek Demo site:
  - The Greek Demo Site involves the 3 main actors of the energy data value chain: 1. HEDNO, as the Greek **Distribution System Operator**, is a key industry partner involved in the integration of the electricity distribution network operations and relevant data platforms to provide support at the deployment of the pilot in Greece, which is located in the area of Mesogeia, nearby Athens. **HEDNO provides access to data referring to their distribution network assets**.
  - 2. IPTO, as the Greek **Transmission System Operator**, is responsible for the operation, maintenance, and development of the Hellenic Electricity Transmission System. **IPTO offers access to data related to energy transfer infrastructure and assets**.
  - 3. CoEn, as the Greek representative of **Local Energy Community**, tests and validates relevant applications that **facilitate the participation of prosumers in data/ flexibility sharing and transaction schemes** while enabling the **integration of the energy system with the building sector.**
- Spanish Demo site:
  - The Spanish Demo Site involves 3 main actors of the energy data value chain:
  - Cuerva (local DSO and retailer) offers access to the distribution network operated in the region of Granada as the main electricity infrastructure to set the Spanish demo site.
  - Fornes Municipality, as Local Authority, tests Synergies solution proving real-time data streams from 30 selected buildings while **enabling the integration of the energy system with the building and electromobility sectors**.
  - Turning Tables, as **Local Energy Community Operator**, is capable to effectively involve their prosumers and offer access to a variety of energy and data assets, as well as to coupled sectors' assets.
- Danish Demo site:
  - The Danish Demo Site involves 2 main actors of the energy data value chain:

- **TENØ**, as the Danish Distribution System Operator, is involved in the integration of the electricity distribution network operations and relevant data platforms to provide support for validating the effectiveness and evaluating the envisaged impact to be achieved through the deployment and use of the SYNERGIES solutions.
- **BEOF**, as Local Utility and Energy Community Operator, enables **the validation of scenarios referring to off-grid assets' operation with the inclusion of the large-scale local generation and storage assets to enable the operation of the Bornholm Island network in an isolated manner and non-interconnected manner.**

4.4 EDDIE

Among the sister projects, EDDIE (**E**uropean **D**istributed **D**ata Infrastructure for **E**nergy) is the one starting the latest. The official kick off of EDDIE was in January 2023. Therefore, at the time this report is being written, there is not very much information available.

This way, the following table assessment might not be as detailed and accurate as the previous ones. If needed, the assessment will be refined in future versions of this report.

Table 10. Assessment of EDDIE project

Project name		EDDIE
Project type		Sister Project https://eddie.energy https://cordis.europa.eu/project/id/101069510
Interoperability	Architecture framework	EDDIE plans to set up an Energy Data Space, but there is no mention on the public documentation about the references to be used for this. It is very likely that they will end up aligning as well with GAIA-X and IDSA, but this is something to be discussed in detail with them.
	Software / API interoperability	Project EDDIE [36] investigates another direction to establish a European communication layer above the MS data exchange environments to provide a harmonized European interface. Considering the shortfalls experienced through the deployment of centralised, inter-dependent and inflexible platforms, the EDDIE consortium proposes a completely decentralised, distributed, open-source Data Space solution, aligned with directions of the work on the Implementing Acts on Interoperability as mandated by Article 24 of Directive (EU) 2019/944, the European Data Strategy and accommodated with the European Data Spaces Initiative. From the project's viewpoint, grid operators, smart energy system actors and. first and foremost. data-sharing infrastructure operators must team up to unlock the full potential of data-driven services and establish the grounds for European players to pioneer this especially important domain.

Project name		EDDIE
Interoperability	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	No information at this point. It is assumed no alignment is made so far.
	Semantic interoperability	The project aims to assist EU DSO Entity, ENTSO-E and SmartEn, amongst other organization in their efforts to standardize data exchange for retail markets, the utilization of distributed flexibility and energy-data. related business models. Being under the umbrella of the Int:Net Coordination and Support Action, it will also connect with initiatives like FIWARE, the Common Information Model for Electricity/Energy and help to prepare the grounds for a common European Energy Data Space.
Marketplace		There is no mention discovered at this stage regarding the utilization of any sort of marketplace in EDDIE.
Innovative business models		Project EDDIE will just start with the data-sharing scope defined and regulated by the Implementing Acts for Interoperability following Article 24 of Directive (EU) 2019/944. Soon after this has been achieved and rolled out, the vision is to extend the pattern also to other processes that are currently under consideration also by legislation and regulation. Having sustainability and development over time as priorities, the project's exploitation and sustainability strategy is directed towards creating an active, self-sustained and properly governed open source community.
User involvement and co-creation / Societal impact		There is no information available on this still. Nevertheless, as a sister project, SSH is expected to be tackled in the project as suggested by the European Commission in the call for proposals.
Main business use cases		EDDIE aims at bringing together information from Data-sharing infrastructures (member state by member state), in-house data sources and public available data, but it is not yet clear what the data sharing use cases behind this grouping of data are. No details are available yet.

Project name	EDDIE
Supporting tools for deploying Data Spaces	EDDIE utilizes Apache Kafka Open-Source streaming technology and containerized infrastructure to enable full de-centralisation, high scalability while enabling real-time streaming data exchanges. The proposed platform will be deployed through Open-Source components and deployable easily in developer desktops as well as in cloud-native environments. Communication is done directly from data source to data-driven service and there will not be a need for a central intermediary. The framework is designed to be extensible to support requirements of distributed flexibility, aggregation for every future flexibility market.

EDDIE provides views on Energy Data and is focussed on EU regulation supporting Data Access as illustrated by the following Figure 5:

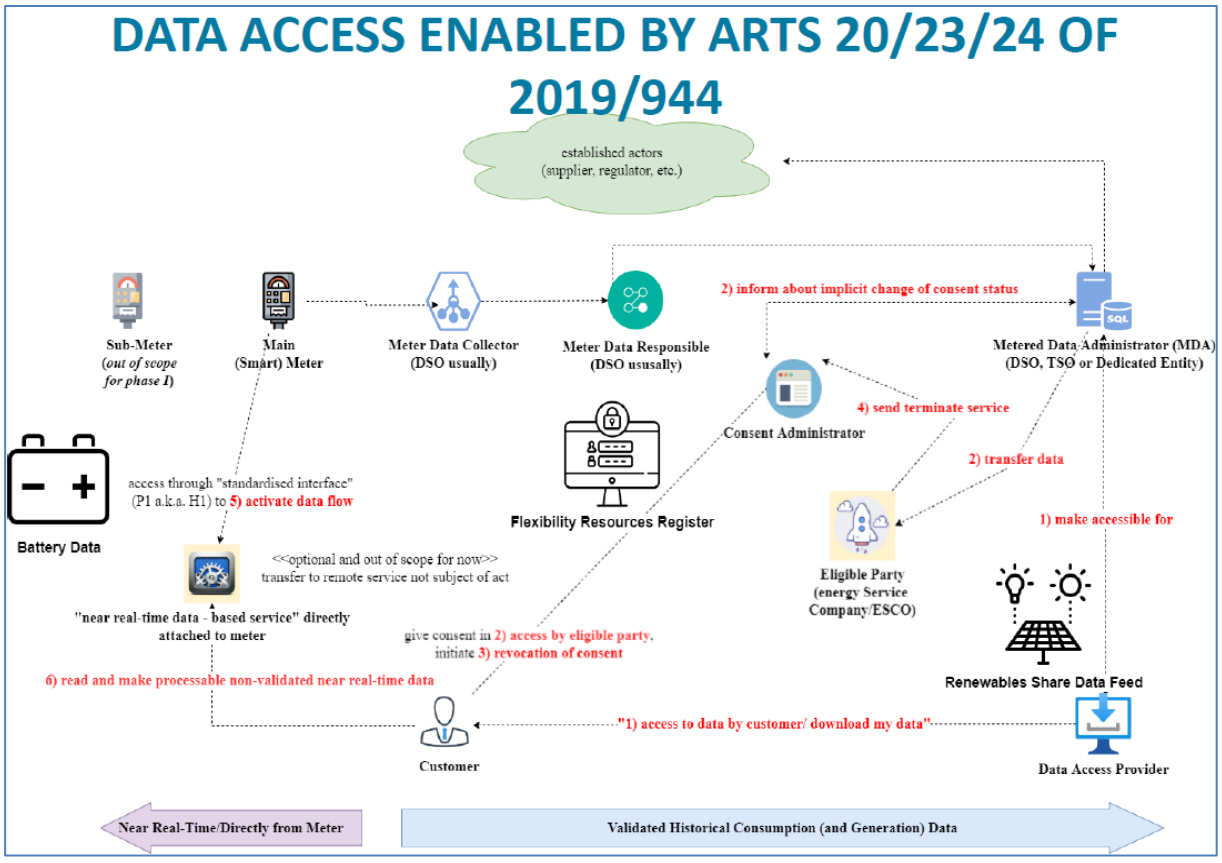

Figure 5. EDDIE focus on EU regulation

The main objective is to create a dependable, scalable, and extensible European Distributed Data Infrastructure for Energy Framework (see Figure 6. Grouping of data access challenges to get to a uniform interface) streamlining the access to (1) data accessible through data-sharing infrastructure (e.g., grid operators, connection point registries, etc.) (2) in-house citizen

data and (3) publicly available data (like price signals from exchanges or information on the current electricity mix available).

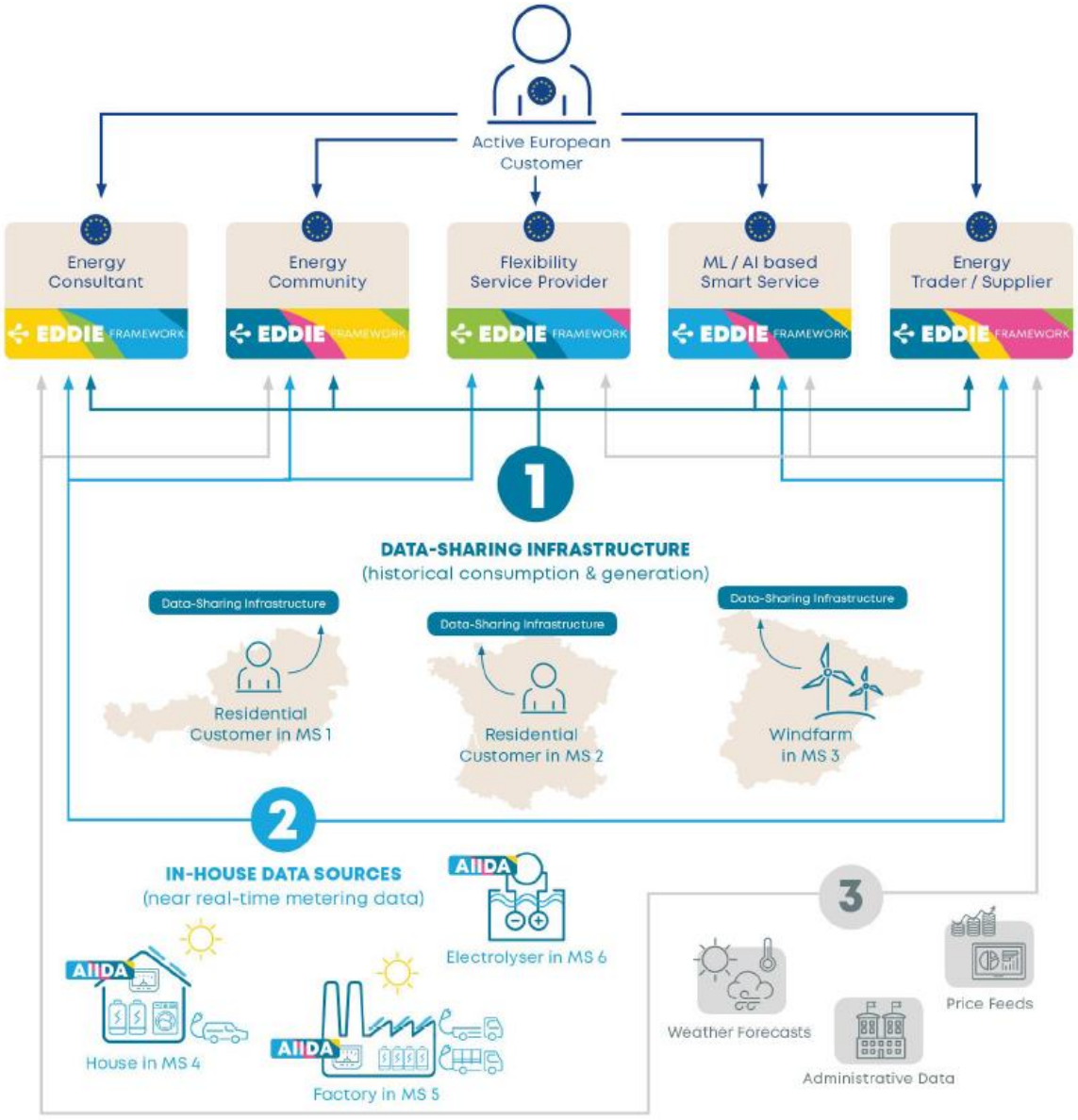

Figure 6. EDDIE Framework

Connectors are going to be developed and implemented in 3 phases. With interoperability, the connectivity with data-sharing infrastructures and European Data Spaces, Project EDDIE. European Distributed Data Infrastructure for Energy. fulfils 2 key priorities of the European Commission's Action Plan for the Digitalisation of the Energy Sector (DoEAP). Figure 7 illustrates EDDIE phases and participants.

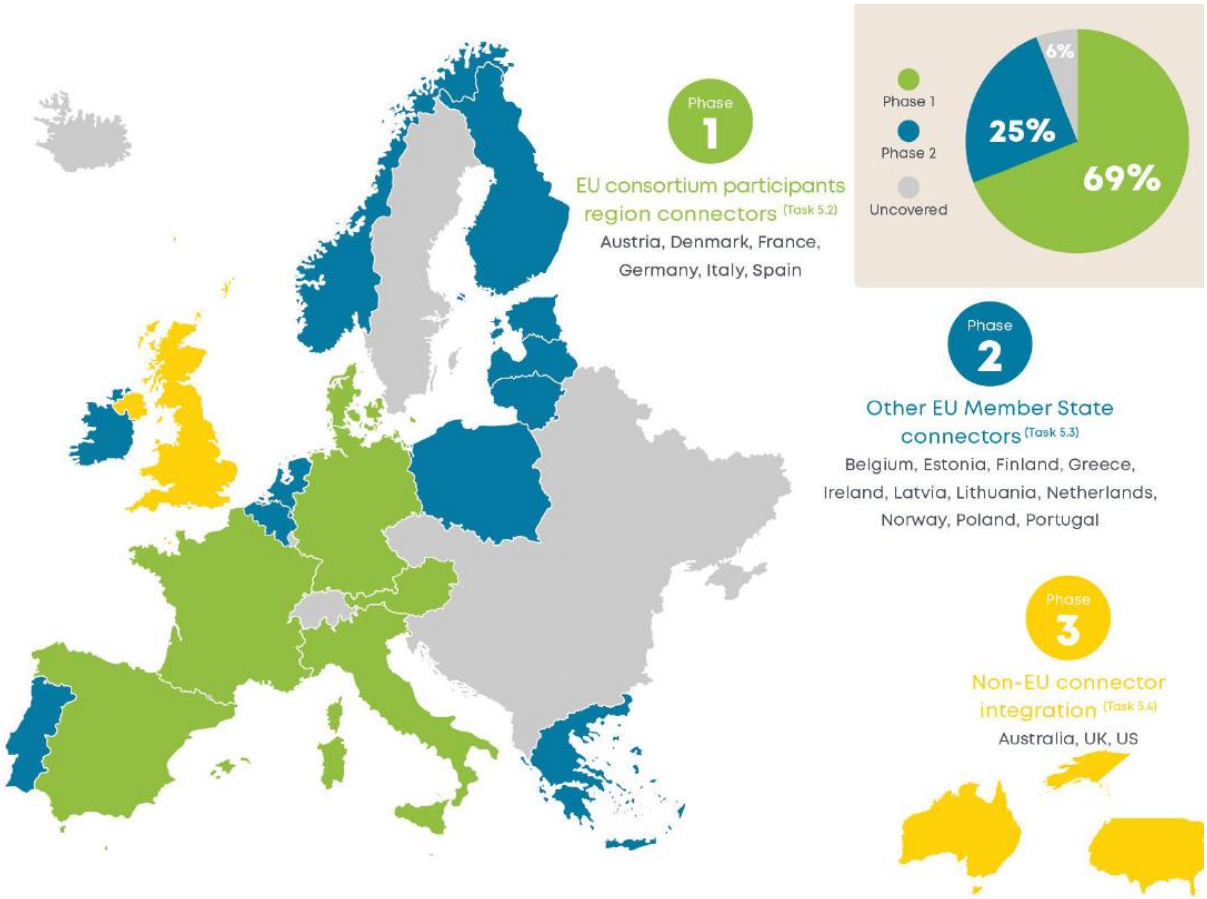

Figure 7. EDDIE phases and participants

4.5 Discussion on Sister Projects

This section synthetises the approach followed by the different sister projects regarding different fundamental aspects analysed in the individual project assessment explained in the previous sections. The aim of this analysis is to find a common ground amongst different sister projects to demonstrate the interoperability amongst the data spaces developed in different projects.

Regarding the interoperability aspects it seems patent that OMEGA-X, ENERSHARE and DATA CELLAR (to be confirmed in a later stage) will follow an overall similar approach regarding reference architecture (based on GAIA-X, IDSA and FIWARE), semantic data models and open APIs. Nevertheless, there are specific aspects that will need to be closely monitored to ensure full interoperability. These aspects include: compatibility of GAIA-X trust framework (SSIDs), interoperability amongst different connectors (e.g. Eclipse Data Space Connector vs TRUE connector) and common semantic data models (based on SAREF, SEAS, SEEDMON…) for different use cases that should be aligned with existing widespread IEC standards. In the case of SYNERGIES and EDDIE although there is no mention on the public documentation about the references to be used for this. It is very likely that they will end up aligning as well with GAIA-X and IDSA. Also, these two projects have started later than the previous 3 projects, so, it makes sense to follow the defined common interoperability framework. In return they could focus on other important aspects such as common

standardisation strategy considering the expertise of the consortium. However, this is something to be discussed in detail with them.

Regarding the deployment of cutting-edge technologies, different projects are addressing different state-of-the art applications to fulfil the requirements of the specific use cases. However, the developed common framework should be agnostic to the specific applications, hence, it should not have any impact and there is no need to monitor this aspect in the future. Please bear in mind that this reflects the status of the different projects as of March 2023. The information will be updated in subsequent versions of this deliverable as the maturity level of the different projects evolves.

Regarding the marketplace, along with the interoperability framework explained above, it is probably the most relevant component to ensure the interoperability of the different data spaces developed in the different projects. In fact, this will be the one-stop-shop where users and companies beyond the project will be able to discover the different datasets and services. In this sense, it does not seem reasonable that one has to go to the specific marketplaces developed in each of the specific projects and perform an individualised search. Equally, it seems naive to assume that there will be one single portal that will have all the data and services, not only for energy, but also cross sector at a European level that everyone will adhere to. Thus, it seems reasonable to think that there should be a federation of marketplaces in line with the federation of data spaces that will allow the user to find the datasets/services not only hosted in the specific data space but also in other data spaces from sister projects and initiatives. In order to be able to achieve this, it is crucial to define a common marketplace specification as part of the common minimum interoperability framework amongst sister projects. As of today, this does not seem to be the case as for example OMEGA-X and ENERSHARE plan to use different approaches. OMEGA-X is leaning towards GAIA-X federated catalogue approach while ENERSHARE plans to use a blockchain based marketplace. This problem should be tackled as soon as possible. It makes sense that this should be tackled through the Energy interoperability task force organised by IDSA to agree a common approach aligned with the blueprint that will be defined by the Data Spaces Support Centre.

Regarding the use cases, the table below provides a recap for the assessment of the four Sister Projects in comparison with Use Case Families identified in OMEGA-X. Looking into the results it seems that all the projects (except EDDIE where no information regarding use cases is available yet) will cover Local Energy Communities. In order to demonstrate the interoperability amongst data spaces apart from the federated marketplace demonstration we believe there should be a cross-project use case that will demonstrate some minimum functionalities concerning the sovereign exchange of data and services. Hence, it seems reasonable to assume that it would be adequate to build this minimum cross-project use case around the Local Energy Communities. It seems reasonable that the definition of the cross-project use case should be defined towards the end of 2023 when all the projects have reached a minimum maturity level. These conversations should be led by respective Coordinators/Technical Coordinators from the different projects with the support from Int:Net.

Table 11. Assessment of sister projects

OMEGA-X	Data Cellar	Enershare	Synergies	EDDIE
Renewable	V	V	X	Not available yet
Local Energy	V	V	V	Not available yet
Electromobility	V	V	X	Not available yet
Flexibility	V	V	V	Not available yet

Regarding the innovative business models and user engagement, although there is limited information at the moment all the projects are mandated to work on these two aspects. Therefore, it might make sense to organise some common workshops around these topics specially focusing on the common cross-project use case regarding Local Energy Communities where user engagement and innovative business model play a fundamental role. These common workshops should be organised along with the definition of the cross-project use cases. This should be co-organised by respective SSH leader from different sister projects with the support from Int:Net.

5 5 Cross-domain Actions

OMEGA-X partners are also participating in cross-domain actions like Int:Net and BRIDGE. The following paragraphs summarize these participations.

5.1 Interoperability Community: Int:Net

Int:Net establish an open and cross-domain community: The Interoperability Network for the Energy Transition [37] . The Int:Net-interoperability network brings together all stakeholders relevant for the European energy sector to jointly work on developing, testing and deploying interoperable energy services.

The Int:Net-interoperability network will be formally established to exist beyond the project lifetime. With a comprehensive, FAIR knowledge platform and a series of attractive events, the Int:Net-community guides those who deal with the heterogeneous interoperability landscape of energy services.

Int:Net plays a pivotal role in the strategy for being interoperable with the sister projects. Being a Coordination and Support Action (CSA), the EC has requested Int:Net to be the facilitator of the needed discussions to reach interoperability, considering both the technical and use case levels.

This way, Int:Net does not per se align with the goals and requirements of OMEGA-X, but will be the forum where the project plans to engage and discuss with the sister projects. So far, OMEGA-X has participated in the following events in this respect:

- An Int:Net interoperability workshop was organised in Brussels, together with the sister projects and some special attendees (the EC, EDSO, ENTSO-E and ENEL) in September 30th 2022
  - meetings have started in February, in order to set up interoperability tests in May, leveraging IEC CIM standard and Common Grid Model Exchange Standard (CGMES) profile (IEC 61970-600-1, IEC 61970-600-2). Some OMEGA-X partners are following this activity.
- An Int:Net meeting was organised during ENLIT conference in November 30th 2022.
- An Int:Net standardization workshop was organized in December 12th 2022.

Furthermore, Tecnalia is a partner of the Int:Net project. Specifically, Tecnalia is leading the task for identification and analysis of cross project use cases. In this sense, Tecnalia is building a radar of different use cases including several initiatives related to energy data spaces covering sister projects defined in this deliverable and others.

In January 2023 Int:Net asked all concerned sister projects to describe their use cases using an Int:Net template derived from IEC 62559-2. The future version of this deliverable will also refer to this Int:Net initiative.

5.2 BRIDGE alignment

The BRIDGE initiative helps identify and structure cross-cutting innovation issues that may be an obstacle to innovation in smart grids, energy storage, islands, and digitalization. This is done by sharing knowledge and expertise between projects through the delivery of conclusions

and recommendations. For 2022-2023 there are four active BRIDGE working groups: **Data Management**, **Business Models**, **Regulation**, and **Citizen and Consumer Engagement**.

OMEGA-X is participating in the BRIDGE initiative by engaging in its working groups with contributions; namely: towards adopting data spaces in a federated marketspace, along with identifying existing challenges and what needs to be tackled within OMEGA-X to arrive at the project objectives. The following sub sections describe the action points within each BRIDGE working group and respective OMEGA-X collaboration. Therefore, this report will record the first-year (May 2022. April 2023) liaisons and collaboration activities outlined for OMEGA-X alignment with BRIDGE.

5.2.1 Data Management Working Group (DM WG)

In the year 2022-2023 the DM WG will have the opportunity to work on five actions. The description of what the Data Management WG will be working on in 2022-2023 is in next table.

Table 12. BRIDGE Data Management Working Group actions and sub actions in 2022-2023

Description	OMEGA-X participation
Action #1. BRIDGE use-case repository (continuation) Sub action 1.1: Test the use-case repository new functionalities	Following up. Contribution expected for 2024 when OMEGA-X UC are ready
Action #2. Data Exchange Reference Architecture (continuation) Sub action 2.1: Continue pilot implementation of the reference architecture, including Mapping to SGAM (e.g., using SGAM Toolbox); Data modelling, profiling; (Maybe: implementation/development) Sub action 2.2: Improve visualisation and usability of the reference architecture, e.g., by applying Unified Modelling Language (UML) Sub action 2.3: Follow the implementation of individual recommendations related to reference architecture Sub action 2.4: Add data governance layer to the reference architecture Sub action 2.5: Improve DERA, incl. its contribution to Digitalisation of Energy Action Plan (DoEAP)- i) On strategic level. ensure the inclusion of cross-sector perspective, interoperability of sectorial data spaces and governance aspects ii) On operational level. benefit from BRIDGE data exchange reference architecture	Participation per sub action: 2.1: OMEGA-X is not mature enough to test pilot implementation. Will do in 2023-2024 2.2: Collaborating in the visualization and link to sub action 2.5 2.3: Filled in the survey to produce new recommendations 2.4: Filled in the survey 2.5: Leading the definition of DERA 3.0 (cross-sector reference architecture) with more links to Data Spaces
Action #3. Reference framework (continuation and extension) Sub action 3.1: Identify and develop new Generic Business Processes	Participation per sub action: 3.1: Contribution through sharing UCs to build

Description	OMEGA-X participation
Sub action 3.2: Further investigate the Flexibility settlement subprocess	Generic Business Processes (2024) 3.2: Contribution on flexibility settlement procedures
Action #4. BRIDGE user group (continuation)	Lead the user group and contribution on standardisation: semantics, cyber
Action #5. Interoperability of home appliances (new action) Sub action 5.1: Define the methodology and prepare a survey to collect data from projects. Sub action 5.2: Analyse the data from the projects and write the report	-

Figure 8 illustrates BRIDGE Data Management working group organisation:

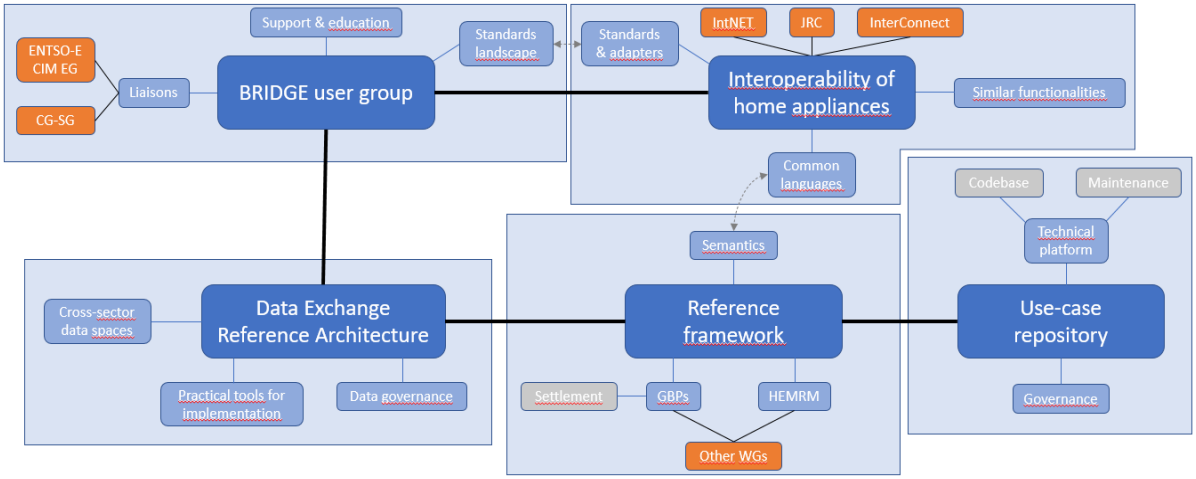

Figure 8. BRIDGE Data Management structure

5.2.2 Business Models Working Group (BM WG)

In the year 2022-2023 the BM WG will have the opportunity to work on two topics. The description of what the Data Management WG will be working on in 2022-2023 is in next table.

Table 13. BRIDGE Business Models Working Group topics in 2022-2023

Description	OMEGA-X participation
Topic#2. Design of tools to evaluate the benefit of the services and solutions (continuation) Proposed tasks: • Investigate the tools to capture business ideas and build BM (e.g. BM canvass, radar, etc.) • Quantification methods for BM benefits of services and solution under various UC scenarios	Preparation and analysis of an online questionnaire (covering all BM WG topics) that is collecting the inputs of all BRIDGE participating projects.
Topic#3. Design of BM to better include data value chain observability (continuation) Proposed tasks: • Investigate the types and characters of the data value chains in Business models of BRIDGE projects	Previously referred questionnaire and contribution on task 3 under the participation of UCP as co-leader of this task.

5.2.3 Regulation Working Group (R WG)

In the year 2022-2023 the R WG will have the opportunity to work on four actions. The description of what the Regulation WG will be working on in 2022-2023 is in next table.

Table 14. BRIDGE Regulation Working Group actions in 2022-2023

Description	OMEGA-X participation
Action 1: Improve market access for consumers to value their flexibility. (continuation) i) Main question to be solved: Which regulatory barriers for consumers exist that hinder the valorisation of their flexibility via implicit (tariffs) and explicit (markets) flexibility mechanisms, and consequently, what are possible solutions to overcome these barriers. ii) Topics in scope (but not limited): flexibility products and services, rules for aggregation, tariff design, market processes (prequalification), smart appliances, etc	Participating in all meetings and answering a survey related to this action.

Description	OMEGA-X participation
Action 2: Service provision by energy communities. (continuation) i) Main question to be solved: What are the possible grid services energy communities could deliver to support the future needs of the grid (both transmission and distribution). ii) Topics in scope: design of grid services and associated products, relation with the system operator, financing models iii) This action will focus on a joint paper with ETIP SNET/ISGAN. working title 'Service provision by energy communities'	Participating in all meetings and already answered a survey related to this action.
Action 3: Facilitate flexibility market coordination and integration. (continuation) i) Main question to be solved: What are existing 'market design' barriers (and possible solutions) to arrive at integrated and coordinated markets in Europe, and consequently, what are possible solutions. ii) Topics in scope (but not limited): TSO-DSO coordination, local market design, value stacking, etc.	Participating in all meetings and answering a survey related to this action (comments requested before answering the survey itself).
Action 4: Support the potential synergies coming from increased sector coupling/sector integration/system integration. (new) i) Main question to be solved: Which regulatory barriers exist that limit the potential of sector coupling/sector integration. ii) Topics in scope (but not limited): service provision by E-mobility, integration with heat, sector integration at the household level, offshore wind integration	Participating in all meetings and already answered a survey related to this action.

5.2.4 Consumer and Citizen Engagement Working Group (CCE WG)

In the year 2022-2023 the CCE WG will have the opportunity to work on two subgroups. The description of what the Consumer and Citizen Engagement WG will be working on in 2022-2023 is in next table.

Table 15. BRIDGE Consumer and Citizen Engagement Working Group subgroups in 2022-2023

Description	OMEGA-X participation
Subgroup Indicators of Engagement: To collect qualitative and quantitative indicators to assess consumer engagement over time. Taxonomy of indicators of engagement with: • Assessment of the purposes of the indicator • Assessment of advantages and disadvantages of the indicator • Assessment of indicators usefulness in different phases of a project • Assessment of the usefulness of indicator for specific user/stakeholder groups Taxonomy of problems associated with the assessment of indicators of engagement and best practices on how to reduce them	
Subgroup Smart Tools: To collect a list of Smart Tools targeted consumers and the approaches to development and use. Design Thinking approach (development aspect): • Establish definition of Design Thinking with project examples of implementing the approach in the design of Smart Tools Smart Tools for consumer action (use aspect): • Explore methodologies, use cases and experiences with Smart Tools for consumer action such as Demand Response Replication of Smart Tools (use aspect): • Elicit replication requirements	Contributing to Subgroup Smart Tools, in the identification of important lessons learnt: i) foster contributions from experts in related areas ii) promote OMEGA-X solution
Subgroup Strategies of Engagement: To collect strategies and methods and underlying assumptions used by the projects to engage consumers and citizens. • Gather and structure effective strategies of engagement • Understand stakeholders and end users: ○ Stakeholder categorisation ○ Cultural, social, and geographic dimensions • Gender challenges and opportunities for engagement • Managing engagement	-

5.3 Discussion on cross domain actions

OMEGA-X partners have been following BRIDGE and Int:Net closely, not just analysing the documentation but also interacting on regular events and meetings. The consortium plans to

keep doing the same, with expected increase (especially regarding technical actions) for the following cycle.

6 Conclusions

This report has recorded all the liaisons and collaboration activities set up for OMEGA-X, on the basis of the methodology documented in D2.1, mapping 4 different associations related to Data Spaces Initiatives, the four (4) “sister” projects of OMEGA-X, as well as the alignment with CSA actions.

On the front of Data Space Initiatives GAIA-X European Association for Data and Cloud AISBL, the Big Data Value Association (BDVA), FIWARE Foundation, and the International Data Spaces Association (IDSA). all part of the DSBA (Data Space Business Alliance). were analysed covering the different aspects of the methodology: *Interoperability, Deployment of cutting-edge technologies, Marketplace and innovative business models, User involvement and co-creation / societal impact and Use case family operation*. On the basis of this analysis and the commitment of the OMEGA-X project to liaison with these initiatives, a prioritization of topics that will be included in the design and development activities of the project was performed.

The same methodology was applied to the “sister” projects of OMEGA-X from HORIZON-CL5-2021-D3-01-01 topic (i.e. ENERSHARE, DATA CELLAR, SYNERGIES, EDDIE) which aim to establish the grounds for a common European energy data space, with the following outcomes:

- On Interoperability aspects OMEGA-X, ENERSHARE and DATA CELLAR seem to follow a similar approach regarding reference architecture (based on GAIA-X, IDSA and FIWARE), semantic data models and open APIs. Nevertheless, there are specific aspects that will need to be closely monitored to ensure full interoperability (e.g. trust, connector interoperability, semantic models). In the case of SYNERGIES and EDDIE, limited information were available to conclude in their concrete approach on interoperability.
- Regarding the deployment of cutting-edge technologies, different projects are addressing different state-of-the art applications to fulfil the requirements of the specific use cases. However, the developed common framework should be agnostic to the specific applications, hence, it should not have any impact and there is no need to monitor this aspect in the future.
- The assessment of the Use Case Families aspect (with the currently available information), concluded that the Local Energy Communities could be a promising candidate for testing interoperability among the different data spaces projects. Such a cross-project use case should be defined towards the end of 2023 when all the projects have reached a minimum maturity level. These conversations should be led by respective Coordinators/Technical Coordinators from the different projects with the support from Int:Net.
- User engagement activities and Societal engagement in the sister projects are described in D2.1. Stakeholder engagement, user perspectives and communities level is also present in the other use case, though more hidden (see also D2.1). Therefore regarding the innovative business models and user engagement it would be beneficial to organise common workshops around these topics, especially focusing on the common cross-project use case regarding Local Energy Communities. This should be co-organised by respective SSH leader from different sister projects with the support from Int:Net.

Lastly, the coordination initiatives of BRIDGE and Int:Net were analysed in term of scope, structure and recent activities (e.g. meeting, events). OMEGA-X partners have been following

these initiatives closely, actively participating on regular events and meetings. Contributions to technical discussion is expected to increase in the next period.

This report provides an initial analysis of the liaisons and collaborations of OMEGA-X and shall be revised on an annual basis until the end of the project.

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Annexes

The following annexes are not a core priority but complete the monitoring with key elements.

PLATOON (ID 872592)

PLATOON aim is to deploy distributed/edge processing and data analytics technologies for optimized real-time energy system management in a simple way for the energy domain expert. The data governance among the different stakeholders for multi-party data exchange, coordination and cooperation in the energy value chain will be guaranteed through IDS based connectors. The project will develop and use the PLATOON reference architecture, COSMAG-compliant, for building and deploying scalable and replicable energy management solutions that contribute to increased renewable energy consumption, smart grids management, increased energy efficiency and optimized energy asset management. The PLATOON architecture and components are valuable for the different stakeholders of energy sector value chain, starting from electricity supplier, passing through the distributor, the aggregator, the ESCo until the End User. The project is validated in seven pilots of four countries that provide real Energy Big Data cases. It proposes to build the solution based on existing European standards and initiatives for managing the pilots' data, for the access, models, interfaces, governance, and sovereignty. It also foresees to report back the results to the different standardization working groups. PLATOON will facilitate the technology transfer into the market by a well-established tendering process through Open Calls. The project will reinforce the European efforts for modernization of the European electricity grid because it focuses the attention to new smart grids services through data knowledge exploitation. Finally, the project will offer access to cheaper and sustainable energy for energy consumers and maximize social welfare.

PLATOON assessment is described by Table 16.

Table 16. Assessment of PLATOON project

Project name		PLATOON
Project type		EU-funded H2020 Project
Interoperability	Architecture framework	SGAM Use Case Methodology (IEC 62559) FIWARE COSMAG
	Software / API interoperability	Platoon Open API (D2.2 section 3)
	Alignment on GAIA-X Trust and Labelling Frameworks, and Data Exchange specifications	Open Source IDS TRUE (TRUsted Engineering) Connector (https://github.com/PLATOONProject/true-connector) Open Source Data Usage Control App (https://github.com/PLATOONProject/PLATOON_DATA_USAGE) Personal data control app (CAPE)

Project name		PLATOON
interoperability	Semantic interoperability	SEEDMON (Semantic Data Models For Energy) Open Source PLATOON Common Semantic Data Models based on existing standards (SAREF, SEAS, OntoWind…) and extending the concepts/requirements to cover the project use cases (https://sedmoon.crigen.myengie.com/PlatoonPresentation.html), Federated Query Processing (https://github.com/PLATOONProject/DeTrusty) Unified Knowledge Base (D2.3 and D2.4 not publicly available) (https://github.com/PLATOONProject/SDM-RDFizer) Open Source IDS Vocabulary Provider (https://github.com/PLATOONProject/PLATOON_IDS-Vocabulary-Provider) Semantic adapter (https://github.com/PLATOONProject/semantic-adapter)
Marketplace		Metadata Registry: Open source component that unifies the IDS components for Metadata Broker and App Store (https://github.com/PLATOONProject/Metadata-Registry). This is the main component that runs behind the PLATOON marketplace. Semantic annotation of data and service offering according to PLATOON data model (https://github.com/PLATOONProject/E-Falcon) .
Innovative business models		Business case definitions, requirements and KPIs (D1.1)
User involvement and co-creation / Societal impact		No final users were involved.
Main business use cases		No. Only intra pilot data sharing amongst limited pilot partners.
Supporting tools for deploying Data Spaces		Federated Query Processing Knowledge graphs Sovereign Data Exchange for streaming scenario using IDS Hybrid Digital Twins Edge-cloud framework (https://github.com/PLATOONProject/edge-cloud-framework)

Start date: 1st January 2020, End date: 31st December 2022.

OneNet (ID 957739)

While the electrical grid is moving from being a fully centralized to a highly decentralized system, grid operators have to change their operative business to accommodate for faster reactions and adaptive exploitation of flexibility. The topic has been subject of several research projects in the past years and reached a maturity that allows now the consideration of a final level, proposing an integrated view on the grid operations beyond the traditional barriers. OneNet (One Network for Europe) aims at performing this critical step creating the conditions for a new generation of grid services able to fully exploit demand response, storage and distributed generation while creating fair, transparent and open conditions for the consumer. As result, while creating one network of Europe, the project aims to build a customer centric approach to grid operation. This ambitious view is achieved by proposing new markets, products and services and by creating a unique IT architecture. While a single platform for Europe is not thinkable, OneNet proposes innovative mechanisms of platform federation which are the key technical enablers for the proposed vision.

Start date: 1st October 2020, End date: 30 September 2023.

This project is also active in Smart Grid Task Force, Expert Group 1, which is working on Data requirements for future flexibility grid code.

BD4OPEM (ID 872525)

BD4OPEM will develop products and services to improve the planning, monitoring, operation and maintenance of electrical distribution grids, all made available at an open innovation marketplace. BD4OPEM will create a seamless link between energy stakeholders and solutions developed. The Marketplace will ensure secure data flows between data providers and solution providers, resulting in new data-driven business models, enhanced asset management and consumer participation in energy balancing. Target user groups will be able to find relevant solutions provided by different specialized companies. The process will be demonstrated at five pilot sites (Spain, Turkey, Slovenia, Belgium, and Denmark), who provide the initial input data and who will also trial and validate the usefulness and the usability of the services being developed.

Start date: 1st January 2020, End date: 30 June 2023.

OASC

OASC [38] (Open & Agile Smart Cities) is an international network of cities that partners with local administrations of all sizes and all over the world to assist them in their journey towards digital transformation. OASC work with its members, partners, and independent experts to create sustainable impact for its cities via a minimal technical ground for their digital tools and systems. OASC call this the Minimal Interoperability Mechanisms or MIMs. OASC facilitate seamless sharing and re-use of digital, data-driven solutions to avoid vendor lock-in, to reduce innovation costs and improve efficiency, thanks to open standards and APIs (application programming interfaces).

OPEN DEI (ID 857065)

A key position paper [39] named “Design Principles for Data Spaces” has been published by OPEN DEI (Aligning Reference Architectures, Open Platforms and Large-Scale Pilots in Digitising European Industry) with the collaboration of more than 40 data spaces and industrial domain experts representing more than 25 organisations from 13 Horizon 2020 projects and related initiatives.

Figure 9 illustrates how a data space can be created through synthesis of a collection of building blocks, which are integrated in line with the technical architecture, the business structure, and the policy requirements of the data space.

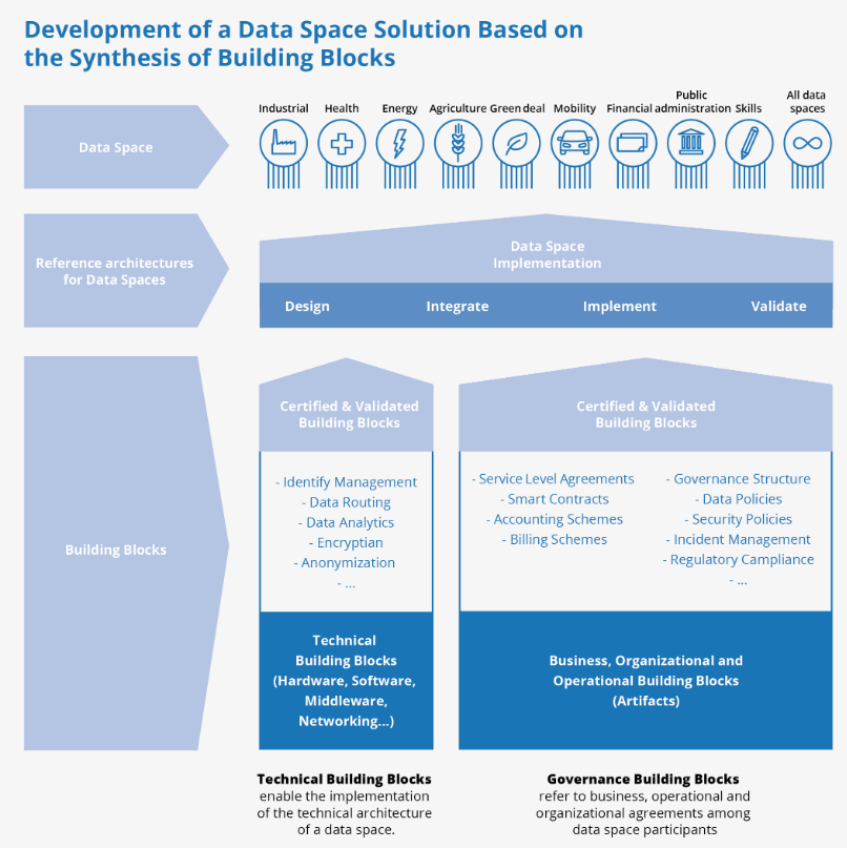

Figure 9. Open DEI Solution based on the synthesis of Building Blocks

Start date: 1st June 2019, End date: 31 December 2022.

InterConnect project (ID 857237)

InterConnect envisages to contribute for the democratization of efficient energy management, through a flexible and interoperable ecosystem where demand side flexibility can be soundly integrated with effective benefits to end-users.In fact, over the last few years several projects and technology providers have come up with solutions that allow every energy user to have awareness and control over his appliances, but there has always been a major issue with interoperability. End-users should be able to choose and change their technology providers, without having to replace their installation, every time they feel this need and still be able to adopt sustainable behaviour and benefit from technological advances.

In the energy sector, a steep move towards digital is occurring and becoming tremendously user-centric and market-driven. The system dimension is significant, as the number of energy service providers is increasing thanks to favourable regulatory environment and technology advancements for monitoring and control.

Start date: 1st October 2019, End date: 31 March 2024.

AI4EU

AI is a disruptive technology of our times with expected impacts rivalling those of electricity or printing. Resources for innovation are currently dominated by giant tech companies in North America and China. To ensure European independence and leadership, we must invest wisely by bundling, connecting and opening our AI resources. AI4EU will efficiently build a comprehensive European AI-on-demand platform to lower barriers to innovation, to boost technology transfer and catalyse the growth of start-ups and SMEs in all sectors through Open calls and other actions. The platform will act as a broker, developer and one-stop shop providing and showcasing services, expertise, algorithms, software frameworks, development tools, components, modules, data, computing resources, prototyping functions and access to funding. Training will enable different user communities (engineers, civic leaders, etc.) to obtain skills and certifications. The AI4EU Platform will establish a world reference, built upon and interoperable with existing AI and data components (e.g. the Acumos open-source framework, QWT search engine..) and platforms.

Start date: 1st January 2019, End date: 31 December 2021.

CEN/CLC/ETSI CG-SG (Coordination Group on Smart Grids)

BRIDGE Data Management working group participated and made a presentation of its Standardisation User Group during CG-SG kick-off meeting organized in November 2022 25th.

Figure 10 describes the CG-SG structure:

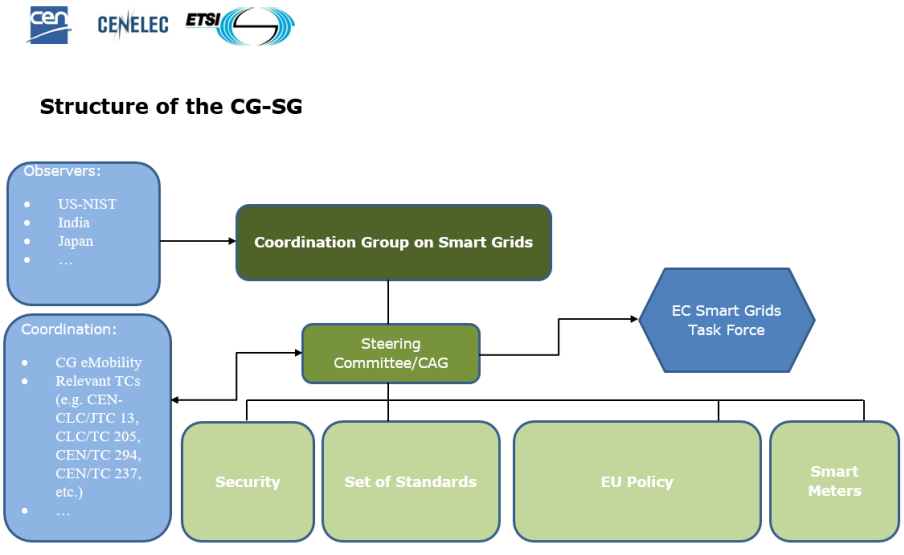

Figure 10. CEN/CLC/ETSI CG-SG structure

IEC System Committee Smart Energy

The BRIDGE DERA architecture was presented in System Committee Smart Energy, working group 6, and will be referred by future IEC SRD 63417 “Guide and Plan to develop a unified smart energy ontology”. This latest document entered a revision phase in March 2023 among IEC technical committees. Some OMEGA-X participants have contributed to this document. It will be taken into account in Omega-x task 4.3.

System committee Smart Energy has a dedicated web site with valuable resources [40] .

IEC Strategic Group 12

IEC Strategic Group 12 Digital Transformation and Systems Approach, as part of its Methodology group, will publish in 2023 two guides: one guide on use cases, and the other guide on systems approach to Standards Development.

The Use Cases methodology is a subset of the science of systems engineering but may apply to any objects (product, component, system), in any ecosystem including the standardization ecosystem, whether or not digital communication technics or software are in use.

Even if Use Cases methodology usage is wider and wider, however, no common freely and generic framework seems existing especially in the context of its usage in standardization, despite the IEC 62559 series content.

Effectively the IEC 62559 series, while providing an excellent starting point suffers from a quite restricted access (thus reduced awareness), and results from the experience of experts mostly coming from a single market domain, the energy one.

To favour an efficient usage and then facilitate reaching the foreseen benefits, especially in the context of standardization IEC has approved the setting-up of a freely accessible guide and associated resources, which is the purpose of this publication.

CATENA-X

With Catena-X [41] , the automotive industry of the future uses a trustworthy, collaborative, open and secure data ecosystem. All players are networked in end-to-end value chains, in which all partners are on an equal ground, have sovereign control over their data and no lock-in effects occur, which provides a sustainable solution for the digitalization of supply chains, especially for medium-sized and small companies, and supports the cooperation and collaboration of market participants and competitors.

The data ecosystem is based on a system architecture that meets the following technical aspects based on the preliminary work of GAIA-X and the International Data Space Association (IDSA):

- Data Sovereignty and Security, and Interoperability:
- Implementation of contractually secured, technologically secure and highly efficient peer-to-peer communication with end-to-end semantics, provided with the Eclipse Dataspace Connector (EDC) designed within Catena-X as the central communication component.
- Provision of network services for data discovery and mediation as well as certified applications based on contractual agreements (brokers)

- Policies and services for identification, authorizations and their monitoring for cross-company cooperation (in terms of federated services)
- One of the most user-friendly environments for setup, operation and collaborative use.

Eclipse Foundation

The Eclipse Foundation [42] provides our global community of individuals and organizations with a mature, scalable, and business-friendly environment for open source software collaboration and innovation.

SIMPL

Simpl [43] is the smart middleware that will enable cloud-to-edge federations and support all major data initiatives funded by the European Commission, such as common European data spaces.

Data Spaces Support Centre (DSSC)

In October 2022, the Data Spaces Support Centre [44] was inaugurated. Funded by the European Commission as part of the Digital Europe Program, the Data Spaces Support Centre will explore the needs of data space initiatives, define common requirements and establish best practices to accelerate the formation of sovereign data spaces as a key element of digital transformation at all levels.

IDSA (additional text)

IDSA is coalition of more than 130 member companies that share a vision of a world where all companies self-determine usage rules and realize the full value of their data in secure, trusted, equal partnerships; and making that vision a reality. The goal of this association is to define global standard for international Data Spaces (IDS) and interfaces, fostering the related technologies/business models that will drive the data economy of the future across industries. Further information regarding the components is described below.

The following list contains descriptions of some of the main components of the IDSA framework. IDSA can be summarized by Figure 11.

- **The IDS Connector:** The IDS Connector is the central technical component for secure and trusted data exchange [45]. The connector sends your data directly to the recipient from your device or database in a trusted, certified data space, so the original data provider always maintains control over the data and sets the conditions for its use. The connector uses technology that puts your data inside a sort of virtual “container,” which ensures that it is used only as agreed upon per the terms set by the parties involved [46] .
- **The IDS reference Testbed** [47] is a setup with Open Source IDS components which can be used to verify that a component implements the IDS specifications for establishing connections and communication and, thus, can work interoperable with all IDS components in the testbed setup. enables the deployment of a **Minimum Viable Data Space (MVDS).** The MVDS consist of a combination of components that enable the initiation of a useable data space with just enough features for secure and sovereign data exchange, as specified by IDSA [48].

- **The IDS Business Model:** IDSA offers a general business model that includes the following roles:
  - **Data owner and data provider**: The data provider is a device that transfers the owner's data to the data space via the IDS Connector.
  - **Data user and data consumer**: The data consumer is a device that processes data on behalf of the user.
    - IDSA also describes some more technical roles:
  - **Clearing House** is the clearing and settlement service for all data exchange and financial transactions within the IDS.
  - **Broker** provides information about data sources in terms of content, structure quality, currency and other features.
  - **App Store** provides applications that can be deployed in IDS Connectors to execute tasks like transformation, aggregation or data analytics.
  - **Identity Provider** creates, maintains, manages and validates identity information of and for participants in the IDS.
  - **Vocabularies** provide standardized descriptors for data based on accepted best practices.
- **The IDSA Rule Book** defines structures and processes for implementing the IDS-Reference Architecture Model in the real world. The Rule Book outlines a governance framework for all players of a data ecosystem, by specifying the functional, technical, operational and legal aspects of data sharing. This includes putting essential services in place as well as defining key processes, such as admission and withdrawal of participants. A new version of the rule book is expected to be published soon (Beta version 2.0 in February 2023, finalised version in spring 2023). IDSA Rule Book is described by Figure 12. In 2022 IDSA has set up a Rulebook Working Group.
- **The IDSA Knowledge Base** [19] contains basic guidelines to the deployment of IDS. It was established in an effort to sort the great amount of information regarding Data Spaces and streamline the learning experience, by breaks down the process of building data spaces into five easy-to-follow steps, guiding the reader all the way from an initial learning phase all the way up to a live and functional data space.
- **Deployment of cutting-edge technologies:** IDSA is not pushing for any given technology, but just providing requirements for composing aligned data spaces. Nevertheless, those requirements are leading to the development and usage of cutting edge technologies such as cloud/edge orchestration, federation of data and services or blockchain-based smart contracts and self-sovereign identifiers.
  - IDSA members have developed cutting edge conceptual and technological solutions that cope with data sovereignty challenges and allow for usage control and data provenance. Among the approaches researched are: The IND^{2}UCE framework for data usage control developed at Fraunhofer IESE, The MY DATA Control Technologies, the Logic based Usage Control (LUCON) and Degree [49].

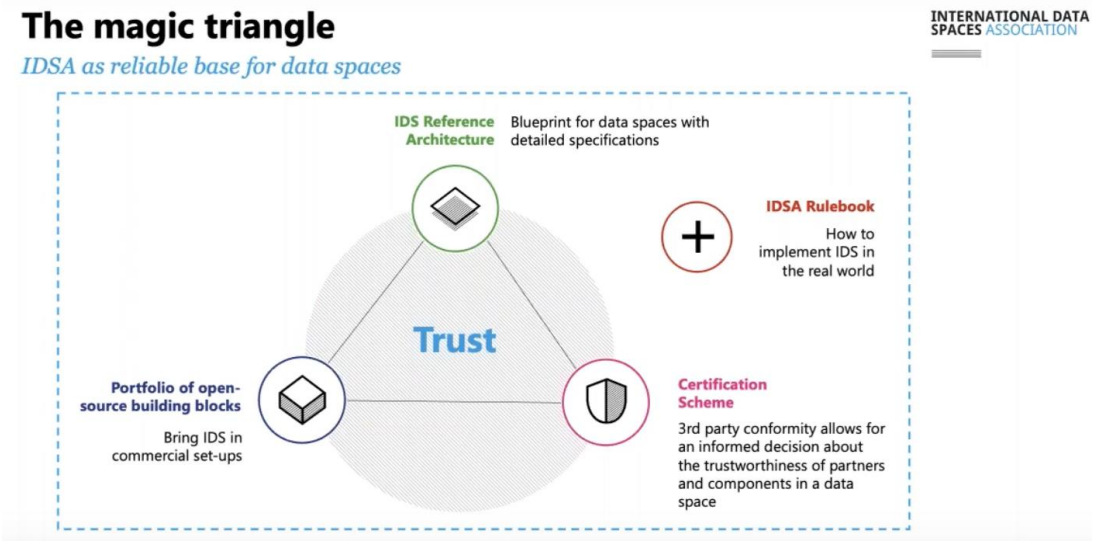

Figure 11. IDSA magic triangle

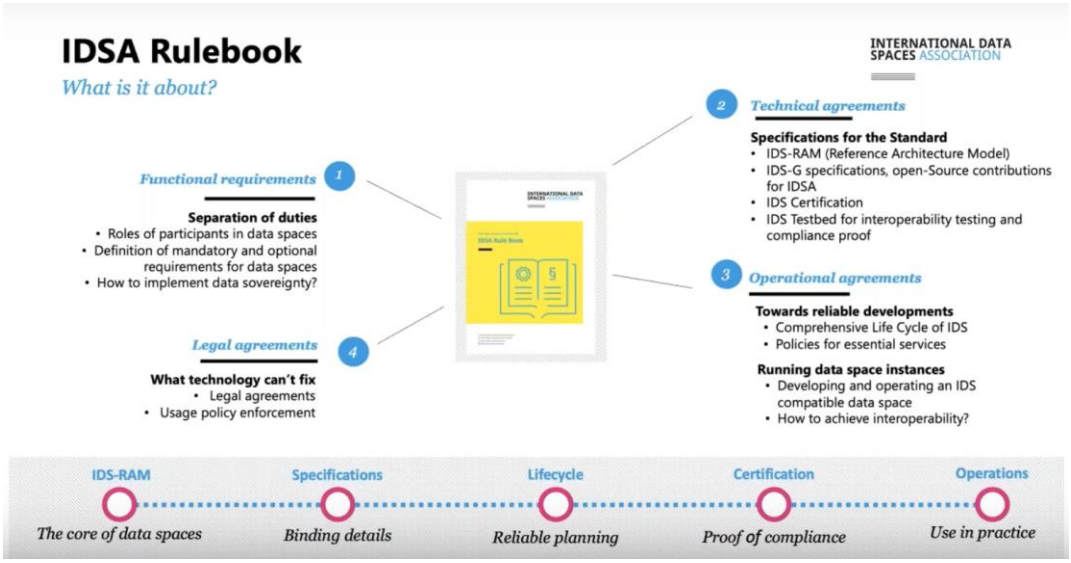

Figure 12. IDSA Rule Book: what it is about ?

ENERSHARE (additional text)

The use case families are:

- Wind Farm integrated predictive maintenance and supply chain optimization. Spain
- Smart Buildings/mobility/smart grid services for LECs and Power Network Operators. Portugal
- Optimal electricity vs heat geo-based planning. Slovenia
- Digital Twins for optimal green hydrogen-based Power-to-Gas planning. Greece
- Community-centred services leveraging on synergies among DSOs, water network and e-mobility. Italy

- Aggregated management of renewable production, flexible consumption and storage capacity. Finland
- Cross-value chain services for public/residential buildings renovation green financing. Latvia

Eleven use cases along seven real-life pilots are developed mixing Intra-Energy Data Space (intra-electricity, across energy sector), and cross sector Data Space.

The ENERSHARE project will implement several pilots associated to the following use cases, as described in D2.1 Enershare deliverable. It describes, as illustrated by Table 17, in its first version, ten use cases of five pilots of the projects. For two pilots the use case analysis is on-going and this document will be updated with the findings in future versions.

Table 17. Enershare use cases

Pilot	Use Case	Title
P1-ES		Wind farm integrated predictive maintenance and supply chain optimization
P2-PT	A	Leveraging on consumer-level load data to improve TSO's operational and planning procedures.
P2-PT	B	Instantiation of energy communities and digital simulation of business models
P2-PT	C	Detect irregularities in energy consumption in households with seniors living alone
P2-PT	D	Suggest maintenance of appliances based on NILM data (Non-Intrusive Load Monitoring)
P3-SI		Optimal multi-energy vector planning. electricity vs heat (will be added in future version)
P4-GR		Digital Twin for optimal data-driven Power-to-Gas planning
P5-IT	A	Cross-sector Flexibility Services for aggregators and DSO
P5-IT	B	Services for e-mobility CPOs, EVs drivers and DSO
P5-IT	C	Flexibility provision for electricity grid with water pumps and predictive maintenance of the pumps
P6-FI		(will be added in future version)
P7-LV		Cross-value chain services for energy-data driven green financing

Each use case is detailed using 62559-2 template. Each use case leverages the HEMRM and related Data associated roles.

P1-ES use case has the following scope and objectives as described in Table 18, which underlines the fact that IDSA reference architecture and components will be leveraged.

Table 18. Scope and Objective of an Enershare renewable use case

Scope and objectives of use case	
Scope	This pilot aims to foster data driven innovation in the onshore and offshore wind energy industry, along its value chain, to maintain its competitive advantage and contribute to the decarbonisation of the economy.
Objective(s)	(i) Design and development of an offshore wind digital platform (IDSA reference architecture and components included) as one of the core technologies, for enabling the federated data sharing and machine learning (ML) based services between data owners and data users; (ii) Enrichment of the IDSA architecture's components with innovative solutions (IDSA connectors in the edge, edge computing, data-driven and Digital Twin based O&M algorithms, synthetic failures data generation) (iii) (3) Creation of the most adequate business model for data monetisation through the platform

Enershare D2.1, reminds DS building blocks as illustrated by Figure 13.

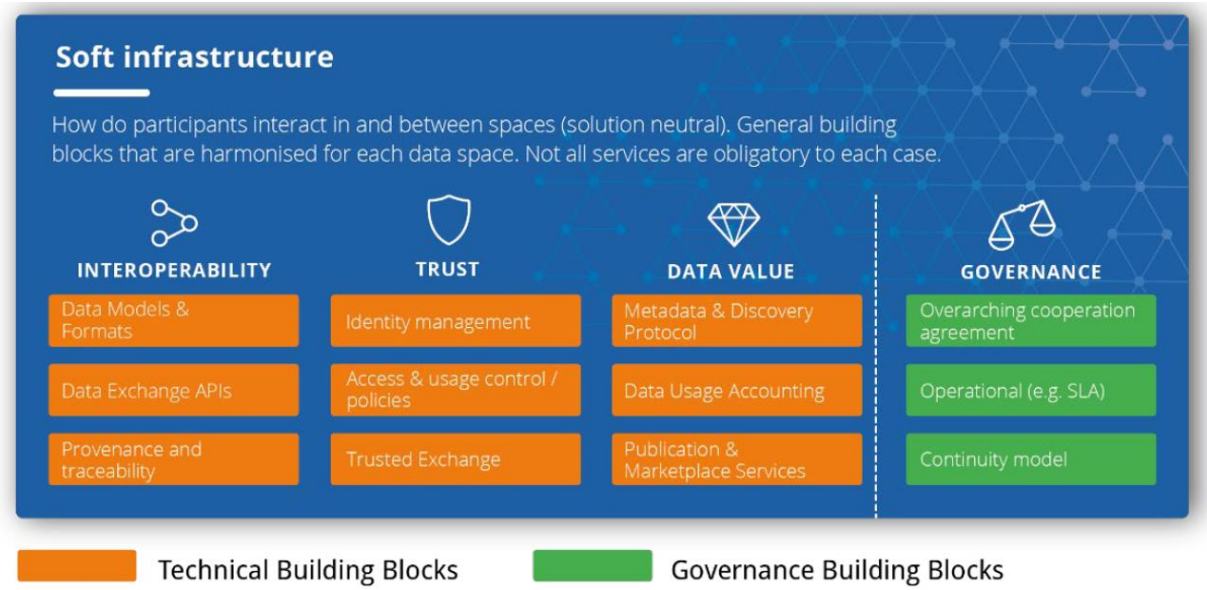

Figure 13. Enershare Data space building blocks

Enershare D2.1 identified which building blocks will be required to implement the process steps within the scenarios, information handling or fulfilment of requirements in the pilot use cases.

summarises how frequently building blocks are needed across the scenarios:

Table 19 summarises how frequently building blocks are needed across the scenarios:

Table 19. Enershare list of technical building blocks of data spaces

Building Block Category	Building Block name	Number of Scenarios
Technical	Data Exchange APIs	20
	Data Models and Formats	20
	Identity Management	19
	Trusted Exchange	19
	Access and Usage control / Policies	16
	Metadata and Discovery Protocol	15
	Data Processing	13
	Publication and Marketplace Services	13
	System Adaptation	9
	Provenance and traceability	7
	Data Visualisation	5
	Data Analytics Engine	3
	Workflow Management Engine	3
	Data Routing and Preprocessing	3
	Data Usage Accounting	1
Governance	Data Space Boards	23
	Continuity Model	23
	Overarching cooperation agreement	23
	Regulations	11
Organisational	Domain Data Standard	16
	Unique Identifiers	2
	Authorisation Registry	0
	Trusted parties	0
Business	Service Level Agreement	8
	Accounting Scheme	1
	Billing / Charging Scheme	1

Building Block Category	Building Block name	Number of Scenarios
Business	Smart Contract	1

Enershare D2.1 concludes with the following key statements:

“The digital ecosystem within the Enershare consortium consists of a balanced mix of data suppliers, data customers and service intermediaries. It spans the digital value chain from the generation and acquisition of data from established systems, generating insights from data analysis and processing to the provision of services to customers.

From the use case analysis there is a clear focus on the core building blocks related to data and trusted exchange. Therefore, the connector framework, the identity management and the required access and usage policies should have high priority in the first iterations of the data space implementation.

There is also potential for cross use case and cross pilot cooperation on data models and format. The most prevalent kind of data is metering data that is relevant in all but one pilot. Furthermore, data on flexibility need and potential and on load forecast are key within pilots 2 and 5 and are well suited to make use domain data standards.

Business building blocks have only been integrated in pilot 5. As sustainable business models are to be created along the creation of the data space this may further be studied within the project as part of task 2.3.

At this early stage of the project, most use cases focus on the core functionalities of data spaces. At the same time they deal with challenging issues on the energy system technology aspect. It may be expected that further functionalities from advanced building blocks will be integrated in future versions of the use case implementations as developers get more familiar with the potentials and available technical components at a later stage.”