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SYNERGIES

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

WP7: Demonstration of Interoperability with Sister Project's Data Spaces and Liaison with relevant initiatives

D7.1: Intermediate Report on Interoperability Demonstration and Liaison activities

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Executive Summary

The current report is providing an overview and consolidation of all activities performed by SYNERGIES towards the definition of the fundamental requirements for a Common European Energy Data Space, in collaboration with the various initiatives and projects implemented at EU level and bringing together various stakeholders, addressing energy data spaces both from a technical implementation and business value perspective.

By considering the current landscape consisting of various initiatives, D7.1 performs the investigation and analysis of the various definitions of (Energy) Data Spaces as elaborated by the European Commission [1], the BRIDGE Initiative [2], the Data, AI and Robotics (DAIRO/BDVA) Association [3], the International Data Spaces Association (IDSA) [**Error! Reference source not found.**], the Data Space Support Centre (DSSC) [5], the Data Space Business Alliance (DSBA) [6], the GAIA-X Initiative [7], and the definition provided in the OPEN DEI Coordination and Support Action [8], aiming at effectively aligning the SYNERGIES concept with all different aspects involved (stepping also on the analysis performed in SYNERGIES in D2.1 [9]) and ensuring that the SYNERGIES Energy Data Space definition (driving all technical implementation activities) is as complete and broad as needed, to evidently facilitate the establishment of inclusive energy (and cross-sector) data value chains built on top of robust mechanisms that enable transparent, secure, sovereign, seamless and interoperable data exchange.

Under this broad Energy Data Spaces definition, SYNERGIES has established a sound basis, consisting in comprehensive technical requirements and specifications, allowing for constructively engaging with sister projects (under the hood of the int:net Coordination and Support Action [11]) and further elaborating on the definition of the minimum and fundamental requirements for a Common European Energy Data Space (CEEDS) [10]. Under this prism, SYNERGIES successfully engaged in intense collaboration activities with sister (energy data space) projects and other key stakeholders, that, through a well-defined and structured process, involving the elaboration of common business use cases and fundamental system use cases, have concluded to the definition of a reference architecture and minimum common building blocks for a Common European Energy Data Space. Business Use Cases focusing on Local Energy Communities, Electromobility, TSO-DSO coordination for flexibility-based management, Smart Home management and RES Integration, have been complemented with common System Use Cases holding a pivotal role in the context of Energy Data Spaces and addressing the minimum requirements of energy data value chain stakeholders for trustful onboarding, federated data discovery and cataloguing, data sharing contracting processes and infrastructures, as well as interoperable data exchange. The reference architecture of CEEDS and the minimum building blocks tailored to facilitate a seamless and secure data exchange, not only within the energy sector but also in conjunction with other related sectors (i.e. the building and e-mobility sectors), have been reported in a common CEEDS blueprint delivered by the cluster of sister projects that is briefly presented in D7.1.

The common CEEDS blueprint and, more specifically, the overarching System Use Cases are currently under intense elaboration and further analysis towards driving the activities for validating the interoperable data exchange among the Energy Data Spaces developed by all sister projects. Interoperability validation and demonstration activities are planned to take place within 2024 and the respective results, findings and conclusions will be reported in SYNERGIES D7.2 [12] due on M42 of the project.

Collaboration with relevant initiatives has been extended to the active participation of SYNERGIES to the various working groups of the BRIDGE Initiative. Starting with the Data Management Working Group, SYNERGIES significantly contributed to the refinement of the Data Exchange Reference

Architecture (DERA) 3.0 [13] providing targeted contributions addressing semantic interoperability enhancement, data privacy, and system sovereignty.
In the realm of business models, SYNERGIES actively engaged in the BRIDGE Business Models Working Group (BM WG) [14], focusing on addressing technology readiness levels and fostering the development of robust, realistic and sustainable business models that can effectively integrate data sharing agreements and transactions across the value chain.

Finally, on the Consumer and Citizen Engagement side SYNERGIES has been actively involved in the activities of the respective BRIDGE Working Group (CCE WG) [15], contributing to the elaboration and definition of strategies for effective stakeholder engagement, ensuring that energy innovations remain user-centric and inclusive.

Regarding the Regulation WG, we need to highlight that during the period covered by the deliverable, it has remained idle and no progress or relevant contributions of SYNERGIES can be reported.

Moreover, SYNERGIES has actively engaged in a series of collaborative initiatives aimed at enhancing interoperability, policy development, and the integration of energy data spaces to support the transition towards a more flexible, digitalized, and sustainable European energy system. Through participation in the Energy Interoperability Task Force led by the Data Space Support Center (DSSC), SYNERGIES contributed to defining a framework for energy domain interoperability. This included brainstorming sessions and workshops focused on technical and semantic interoperability challenges, leading to the preparation of a white paper to guide the sector towards unified interoperability practices. SYNERGIES also provided vital insights into the Data Spaces Survey conducted by DSSC focusing on the analysis and assessment of the degree of alignment with the Data Space Building Blocks defined by DSSC.

Through the collaboration with the European Technology and Innovation Platform for Smart Networks for Energy Transition (ETIP-SNET), SYNERGIES played a significant role in shaping policy recommendations for the deployment of Common European Energy Data Spaces (CEEDS). Contributions to the ETIP SNET policy paper [16] focused on addressing technical, regulatory, and organizational challenges within the energy data space sector.

Lastly, in partnership with EnTEC [17], SYNERGIES explored the role of energy data spaces in energy flexibility initiatives. Through workshops, challenges and opportunities in leveraging data spaces for renewable energy integration and energy/ flexibility management were examined. The collaboration aimed to craft policy recommendations addressing energy market regulation, standardization, data access, and trust considerations.

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List of Acronyms/Abbreviations

Acronym/Abbreviation	Description
AI	Artificial Intelligence
API	Application Programming Interface
BEMS	Building Energy Management System
BM WG	Business Models Working Group
BMC	Business Model Canvas
BRIDGE	European Commission initiative uniting Horizon 2020 and Horizon Europe Smart Grid, Energy Storage, Islands, and Digitalisation Projects
CBA	Cost Benefit Analysis
CCE	Consumer and Citizen Engagement
CEEDS	Common European Energy Data Space
CPO	Charge Point Operator
D	Deliverable
DAIRO / BDVA	Data, Artificial Intelligence and Robotics Association / Big Data Value Association
DER	Distributed Energy Resources
DERA	Data Exchange Reference Architecture
DESP	Data Exchange Standardization and Protocol
DESAP	Data Exchange Standardization Action Plan
DIDs	Decentralized Identifiers
DSO	Distribution System Operator
EC	European Commission
EDS	Energy Data Space
eMSP	e-Mobility Service Provider
EMRSP	Electro Mobility Roaming Service Provider
EnTEC	Energy Transition Expertise Centre
ESCO	Energy Service Company
ETIP-SNET	European Technology and Innovation Platform on Smart Networks for Energy Transition
EVU	Electric Vehicle User
FAIR	Findable, Accessible, Interoperable, Reusable
FSP	Flexibility Service Provider
GDPR	General Data Protection Regulation
GXDCH	Gaia-X Digital Clearing House

Acronym/Abbreviation	Description
HEMS	Home Energy Management System
IDSA	International Data Spaces Association
IDS	International Data Spaces
IoT	Internet of Things
LCOE	Levelized Cost Of Energy
LEC	Local Energy Community
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
OPC-UA	OLE for Process Control Unified Architecture
PoC	Proof of Concept
PPP	Public-Private Partnership
QoS	Quality of Service
RES	Renewable Energy Source
SGAM	Smart Grid Architecture Model
SGI	Smart Grid Initiative
SPU	Service Providing Unit
SPG	Service Providing Group
SoE	Strategies of Engagement
SSI	Self-Sovereign Identity
SSH	Social Sciences and Humanities
SUC	System Use Case
TRL	Technology Readiness Level
TSO	Transmission System Operator
VC/VP	Verifiable Credentials/Verifiable Presentations
WG	Working Group

1 Introduction

1.1 SYNERGIES Project Overview

The growing number of Distributed Energy Resources (DERs) connected to the network continuously expands the energy system "edge", in terms of controllability and operational complexity. The progressive decentralization, which is also accompanied by the introduction of new digitalized assets (EVs, Internet of Things (IoT), batteries), poses significant challenges for the resilience of the system, while introducing increased uncertainty in traditional control routines, given the stochastic and intermittent character of renewable generation and the new control variables (not currently addressed in existing tools for the system management) introduced by new assets.

SYNERGIES introduces a Reference Energy Data Space Implementation [18] 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. The SYNERGIES solution will:

- value the flexibility capacity of consumers in optimizing energy networks' operation, maximizing Renewable Energy Sources (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 assets and coordinating between each other (Transmission System Operator (TSO) and Distribution System Operator (DSO) collaboration) for enhancing system resilience;
- create an inclusive pathway towards the energy transition, through consumer empowerment, awareness and informed involvement in flexibility market transactions;
- step on real data streams and intelligence to deliver personalized and automated features to increase prosumer acceptance and facilitate the establishment of sustainable Local Energy Communities (LECs) by enhancing their role with Aggregator and Business Service Provider functions; and
- 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.

In this context, SYNERGIES aims at re-conceiving data sharing against traditionally bilateral contracting applied in the energy sector and acting as multiplier of the collective data value that can be accrued, shared and traded towards achieving the resilient operation of energy systems through the coordinated optimization of their constituent components (generation, demand, storage) and the orchestrated integration with relevant sectors that can inject significant amounts of flexibility (mobility and EV charging, buildings and heating/cooling systems' control). 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.

1.2 Deliverable Purpose and Structure

This deliverable comprises a report on the preliminary activities performed in collaboration with sister projects towards the definition of Fundamental Requirements for a common European Energy Data Space, the validation of Energy Data Spaces Integration and Interoperable Data Exchange and the interactions performed with relevant initiatives and existing data platforms/datahubs.

The document is structured in twelve different parts:

- **Section 1** introduces the report, setting the stage for what follows.

- **Section 2** delves into the various definitions of Energy Data Spaces, including a specific look at the SYNERGIES project's interpretation.
- **Section 3** outlines the essential requirements for CEEDS, examines Business Use Cases, and surveys System Use Cases, culminating in the identification of Minimum Building Blocks and a High-level Architecture for CEEDS.
- **Section 4** provides a deeper dive into the development and planning of system use cases.
- **Sections 5 to 11** document the array of collaborative activities and contributions made within the various initiatives that the SYNERGIES project is involved with.
- **Section 12** wraps up the report with conclusions and a summary of the discussions presented within the document.

1.3 Positioning in SYNERGIES

Deliverable D7.1, part of Work Package 7 (WP7) on demonstrating interoperability with sister projects and liaising with relevant initiatives, benefits from the diverse expertise of partners involved in similar endeavours. It is directly linked with WP2 through a bi-directional information exchange channel, enabling the transposition of detailed requirements and specification of the SYNERGIES technical components and results to targeted contributions towards the collaborating initiatives, while feeding back to it valuable knowledge and insights from the working sessions and resulting artefacts from the interaction with sister projects and key stakeholders. WP7 further complements Work Package 5 (WP5) focusing on Impact Assessment and Business Planning. This collaboration aims to craft a roadmap for the widespread adoption of the SYNERGIES Energy Data Space across the EU and concurrently aligns with Work Package 6 (WP6) on Dissemination, Stakeholder Engagement, and Business Innovation.

2 Background and Analysis of Energy Data Spaces Definitions

2.1 Overview of Energy Data Spaces Definitions

A data space is commonly understood as a secure, private IT environment where various organizations and individuals can collectively store, access, process, use, and exchange data. Specifically, an energy data space serves as a repository for both historical and contemporary energy data, available on demand. The goal here is to facilitate the flow of energy data across the sector, enabling access for consumers, their authorized representatives, and other stakeholders. Data spaces function as data governance systems, embodying a set of regulations, rules, and agreements that delineate rights regarding data access, utilization, and exchange in a manner that's both trustworthy and transparent. Data proprietors have the authority to determine who can access their data, how it's used, and the conditions under which it's shared. Depending on the data owner's preferences, large volumes of data may be reused, either for a fee or free of charge.

Within the scope of our extensive investigation, it is important to highlight that the detailed analysis of the existing landscape, particularly the intricate aspects of data spaces, was meticulously carried out as part of Deliverable D2.1.

Subsequent paragraphs delve into the definitions and viewpoints concerning energy data spaces from various initiatives including the European Commission, BRIDGE, BDVA/DAIRO, IDSA, GAIA-X, and OPEN DEI, presenting a thorough analysis.

2.1.1 European Commission (EC)

The European Commission outlines a vision through the European strategy for data, advocating for EU-wide, interoperable data spaces in key sectors to break down legal and technical barriers to data sharing. These spaces are envisioned to amalgamate necessary tools, infrastructures, and governance frameworks to ease data pooling and sharing, thereby addressing trust issues with common rules. This initiative aims at creating a unified European data space by interlinking domain-specific data spaces, ensuring broad data sharing and utilization while safeguarding individual and business data rights.

These efforts are further supported by the European Strategy for Data, which emphasizes the creation of a common data space to spur innovation, collaboration, and data interoperability. It advocates for open standards and adherence to FAIR principles, promoting accessible and reusable data across different fields. The proposed European Data Governance Act aims to complement this strategy by offering a legal framework that fosters fair and transparent cross-border data sharing, endorses data altruism, and acknowledges the crucial role of data intermediaries in ensuring secure data transactions and compliance with data protection laws.

Additionally, the European Cloud Initiative and the Commission's Cloud Strategy play significant roles in reinforcing data infrastructure and cloud capabilities, supporting research, innovation, and aligning with data space principles for secure data sharing and processing. The proposed AI Act and the cloud-first approach within the Cloud Strategy align with these principles, aiming to regulate AI systems and promote a secure hybrid multi-cloud service offering across the EU. This holistic approach marks the EU's commitment to maximizing data and AI potential while ensuring data privacy, security, and ethical AI practices, thereby fostering a cohesive and interconnected European data ecosystem for the benefit of both businesses and individuals.

Key aspects of a common European data space include secure and privacy-focused infrastructures for data pooling, sharing, processing, and use, encouraging the development of open standards and FAIR principles. It also involves creating a straightforward structure for data holders to manage data

authorizations and access rights, establishing clear and reliable data governance mechanisms, and ensuring compliance with European laws and values, including data protection and consumer protection legislation. The vision for European data spaces across domains, such as energy, emphasizes interconnectivity, interoperability, and openness to all entities adhering to EU regulations and values.

2.1.2 BRIDGE Initiative

BRIDGE, an initiative by the European Commission, brings together projects from Horizon 2020 and Horizon Europe in the areas of Smart Grid, Energy Storage, Islands, and Digitalization. Its goal is to provide a cohesive overview of overlapping issues and encourage ongoing knowledge exchange through various Working Groups focused on key interest areas. The Data Management Working Group, in particular, addresses several critical topics, including Communication Infrastructure, Cybersecurity and Data Privacy, and Data Handling, which cover both the technical and non-technical facets necessary for secure and efficient data exchange and analysis.

Although BRIDGE has not officially defined "energy data spaces," its 2022-2023 workplan [19] indicates a commitment to exploring this concept, particularly through the development of the Data Exchange Reference Architecture (DERA). DERA has seen three iterations: 1.0 focusing on cross-sector data exchange and interoperability within the energy sector; 2.0 expanding on this by adopting a more sector-neutral perspective while maintaining energy-specific components; and the latest, DERA 3.0, which integrates the concept of Data Spaces and aligns with initiatives like Gaia-X, IDSA, and DSBA. DERA 3.0 enhances standardization and harmonization efforts for data, aiming for secure, interoperable exchanges across Local platforms and Federated Data Space stacks, facilitated by a Data Space Connector.

DERA 3.0's objectives are centered around enabling flexible, business-agnostic data exchanges throughout Europe, enhancing data sharing within and across domains. It recommends adopting the Smart Grid Architecture Model (SGAM), ensuring data governance, harmonizing regulations, and establishing a European data cooperation agency. It also calls for the standardization of data processes, development of a generic data model, and promotion of cross-sector Data Exchange Platforms (DEPs) with APIs, alongside the creation of universal data applications and open data services to support cross-sector integration and a harmonized European data ecosystem.

Key requirements of DERA 3.0, as dictated by the European Commission's Digitalization of Energy Action Plan, include ensuring the availability of non-personal/anonymized energy data, maintaining cybersecurity and data protection, achieving consumer acceptance, adhering to EU data sovereignty principles, promoting open-source solutions and standards, and fostering interoperability across sectors.

DERA 3.0 further emphasizes the critical role of data sovereignty in management practices, advocating for data to circulate freely within the EU, ensuring fair access, establishing reliable governance, and maintaining an open stance on international data flows in alignment with EU principles.

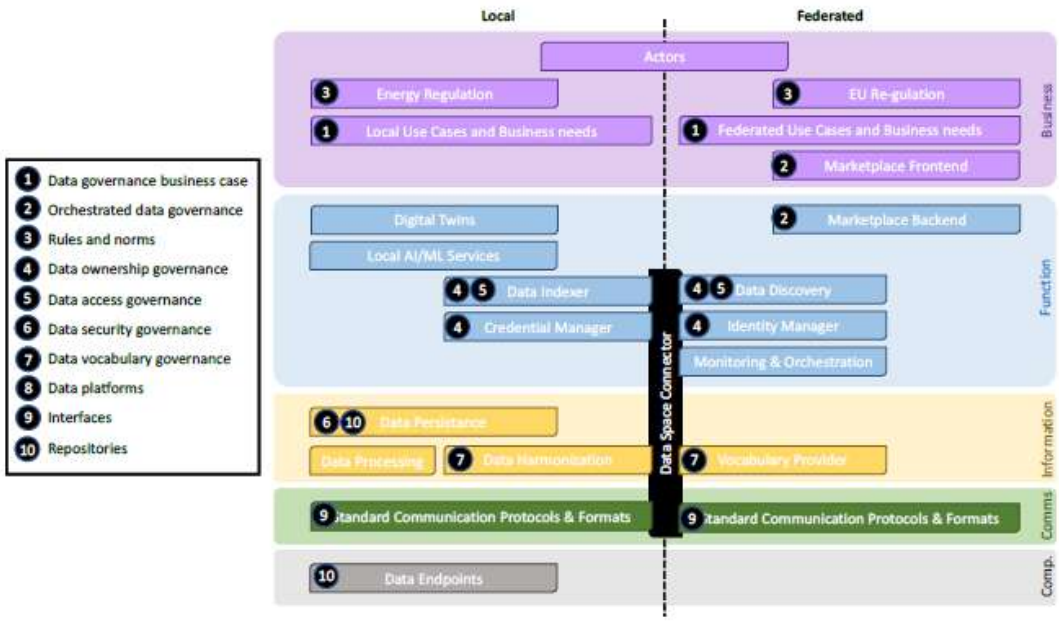

Figure 1 DERA 3.0 Architecture and Link to Data Governance

The progression of DERA signifies continuous endeavours to enhance and adjust the reference architecture, facilitating efficient data management not only within the energy domain but also extending to broader applications.

2.1.3 Data, Artificial Intelligence and Robotics Association (DAIRO)/ ex-Big Data Value Association (BDVA)

Data ecosystems are collaborative networks of diverse, interconnected entities that depend on each other for mutual benefits or compete within the marketplace. Within such ecosystems, data spaces provide structured environments to facilitate data exchange, comprising data models, datasets, ontologies, data sharing agreements, and specialized services like data centers and repositories, along with governance and business processes.

Common European data spaces aim to systematically remove barriers to data sharing, fostering a digital economy with secure and regulated data flows. The Big Data Value Public-Private Partnership (Big Data Value PPP) has funded research and innovation efforts towards establishing common European Data Spaces, marking significant strides towards actualizing data platforms. These platforms, essential for generating, transforming, evolving, curating, and utilizing data, embody architectures and repositories of interoperable tech solutions.

The Big Data Value Association (BDVA) [20] emphasizes the critical role of Data Sharing Spaces, where trust is the foundational element. The BDVA community has unified around the concept of data sharing spaces, highlighting the importance of trust across data, governance, people, organization, and technology. The Data Sharing Value Wheel, introduced by BDVA, outlines the success of large-scale data sharing initiatives as dependent on trust at various levels, including data authenticity, processing algorithms, managing organizations, technologies, and the diverse user community.

The Data Sharing Value Wheel proposes five pillars for achieving trust: Organizations, Data, Technology, People, and Governance, each requiring specific criteria to foster trust. For instance, organizations must prioritize data within their strategies, data must be freely movable with clear sharing methodologies, technology needs to support secure and interoperable data practices, people should be ensured privacy and fair compensation for their data, and governance must reflect European standards and values to inspire trust.

BDVA outlines key conditions for a successful European Data Sharing Space: a trusted framework respecting individual rights and a data lifecycle integration that opens new value chain opportunities. This includes technologies that ensure interoperability, security, privacy, and ethical considerations from the outset.

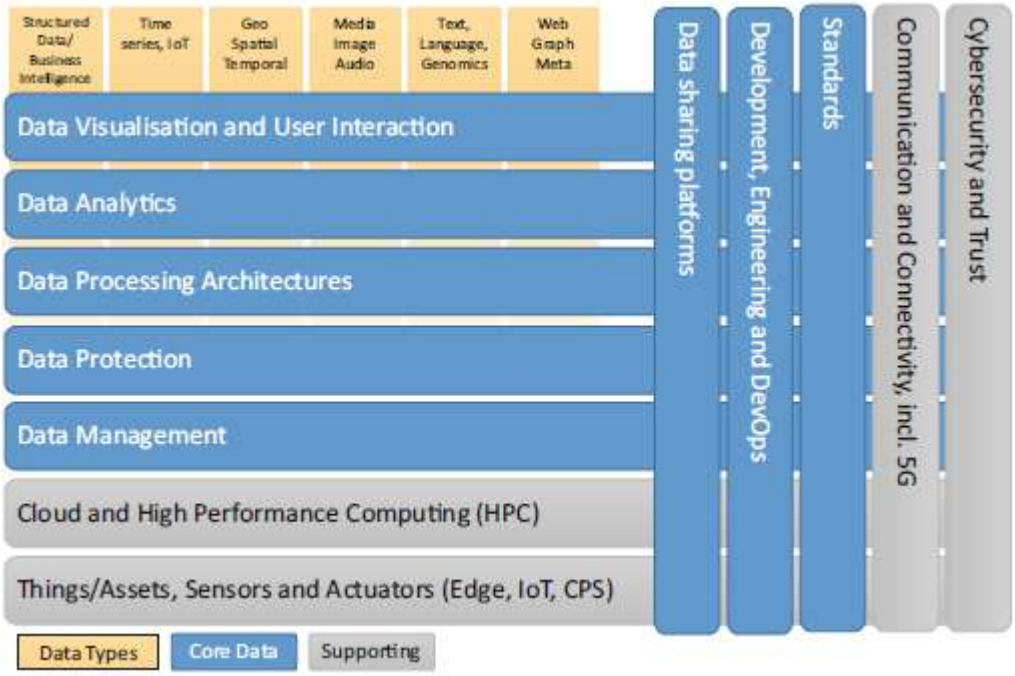

Figure 2 Big Data Value Reference Model

The Big Data Value Reference Model (BDV-RM) aims to address common challenges in the Big Data value chain, fostering a data-driven ecosystem. It categorizes core data processing issues and cross-cutting concerns, covering Data Management, Data Protection, Architectures, Analytics, Visualization, Sharing Platforms, Development, and Standards, supported by infrastructure, connectivity, and cybersecurity.

These initiatives are detailed in the Strategic Research and Innovation Agenda (SRIA) [21], which began with technical papers and roadmaps, setting broad objectives and priorities for research and innovation within the BDV PPP.

2.1.4 International Data Spaces Association (IDSA)

According to the International Data Spaces Association (IDSA), data spaces play a crucial role in achieving sovereign, interoperable, and trustworthy data sharing across businesses and societies. International Data Spaces (IDS) are described as a distributed network of data endpoints, known as instances of the International Data Spaces connector, facilitating secure data exchange while ensuring data sovereignty. Leveraging existing standards, technology, and governance models accepted in the data economy, IDS promotes safe and standardized data interchange within a reliable business ecosystem.

The IDS Association's specification lays the groundwork for a data market based on European principles, prioritizing data privacy, security, equal opportunities, and data sovereignty for owners, all while fostering participant trust. Additionally, the International Data Spaces initiative has outlined a Reference Architecture Model [22] for data integration, characterized by decentralized data management across multiple sources without a common semantic model. Data is generated locally, exchanged based on IDS architectural concepts, potentially stored in various cloud environments, and processed in accordance with specified data usage policies. To unlock the full value of data, it must be describable and tradable using a universal, interoperable standard.

The IDS Architecture ensures that data owners maintain digital sovereignty when sharing or exchanging data by employing dedicated software components like the IDS Connector. This component, deployable across servers, clouds, IoT devices, or smartphones, acts as a gateway for data and services while providing a trusted environment for executing software components through containerization technology, ensuring "trusted execution."

IDSA fosters a federated data-sharing environment [23] that imposes stringent requirements on interoperability across legal, organizational, semantic, and technical levels, aligned with the European Interoperability Framework. Legal interoperability encompasses data-sharing agreements and terms of use, managed by emerging roles and organizations responsible for administration and registration, under an integrated governance approach.

2.1.5 Data Spaces Support Centre (DSSC)

The Data Spaces Support Centre (DSSC) views data spaces as platforms that catalyze a marketplace for diverse entities interested in collaborative data sharing and exchanging. DSSC envisions a data space as an infrastructure designed to facilitate data transactions among various parties within a data ecosystem, guided by the governance framework specific to the data space. Such an infrastructure is intended to be versatile enough to accommodate a wide array of use cases. For instance, industrial data spaces could enable various levels of trusted and secure sharing and trading of commercial data assets, complete with automated controls for legal compliance and compensation.

To foster the growth and development of Data Spaces across the EU, DSSC produced a unified blueprint for data spaces through collective efforts and a community co-creation process. This blueprint consists of both technical and organizational/business components, outlining functional and technical specifications, standards/guidelines, and reference implementations. It seeks to clarify data space concepts, architectural elements, roles, terminologies, and constraints through a conceptual model that takes an asset-based approach to delivering user value. This model clarifies the relationship between various assets within the project, ranging from basic information to comprehensive knowledge on standards and reference implementations.

The DSSC Conceptual Model [24] introduces several Data Spaces Building Blocks, fundamental units and components designed for implementation and integration with other blocks to enable a data space's functionality. On the technical side, these include i) the Data Models & Formats Building Block for efficient data interchange, ii) the Data Exchange Building Block emphasizing the need for protocols in order to maximize interoperability in a particular data space, iii) the Provenance and Traceability Building Block for ensuring observability over the data sharing process, iv) the Access & Usage Policy and Control Building Block for access and usage policies enforcement, v) the Identity Management Building Block for entity information management, vi) the Trust Building Block for establishing trust among participants, vii) the Data, Services, and Offerings descriptions Building Block for facilitating data and service exchanges, viii) the Publication & Discovery Building Block for orchestrating data transactions, and ix) the Marketplaces & usage accounting Building Block for generating value out of data sharing and monetizing data products.

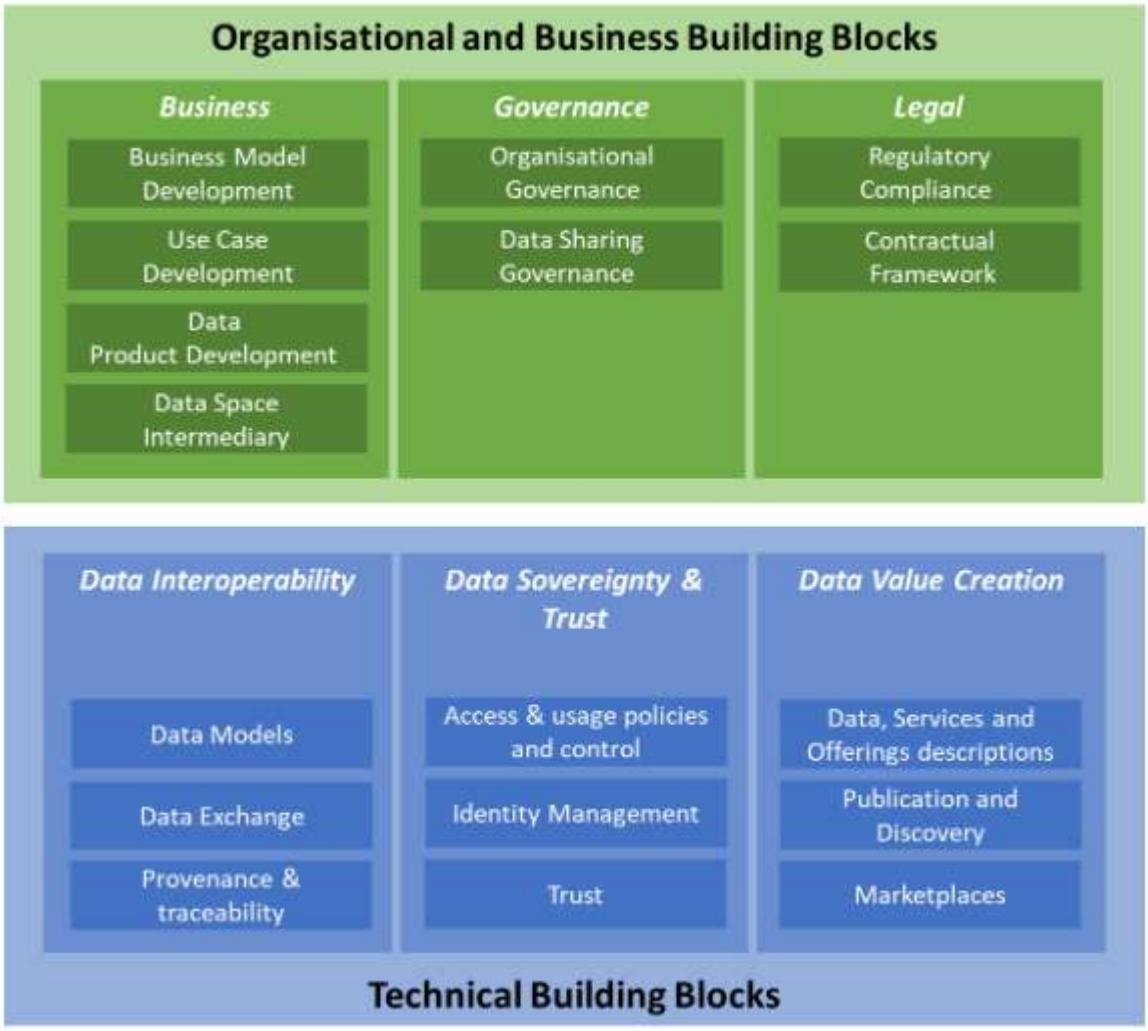

Figure 3 Data Spaces Support Centre – Overview of Building Blocks for Data Spaces [25]

Additionally, the DSSC's Energy Interoperability Task Force is reassessing interoperability practices in the energy sector, aiming to develop an interoperability framework tailored to the sector's unique needs. This task force is committed to applying this framework in specific energy sector use cases to test its efficacy and identify improvement opportunities. Emphasizing standardization, the task force documents its implementations to share insights, best practices, and outcomes with the industry and contribute to standardization efforts. Participants in the task force (INT:NET, OMEGA-X, ENERSHARE, SYNERGIES, DATA CELLAR, and EDDIE) are dedicated to enhancing data exchange and collaboration within the energy domain.

2.1.6 Data Spaces Business Alliance (DSBA)

In a landmark collaboration, the Big Data Value Association (BDVA), FIWARE Foundation, Gaia-X, and the International Data Spaces Association (IDSA) came together in September 2021 to create the Data Spaces Business Alliance (DSBA). Their mission is to promote the adoption of data spaces not just in Europe, but globally.

Data spaces are recognized as pivotal in the journey towards a future Data Economy, essential for enabling sovereign, interoperable, and trustworthy data sharing across organizations and broader society. Illustrated below is the 100-day Implementation Plan introduced by DSBA members.

The DSBA's vision includes crafting a comprehensive reference technology framework that merges the strengths of existing architectures and models, while capitalizing on various infrastructure and

implementation initiatives. The goal of this integration is to foster interoperability and solution portability across different data spaces.

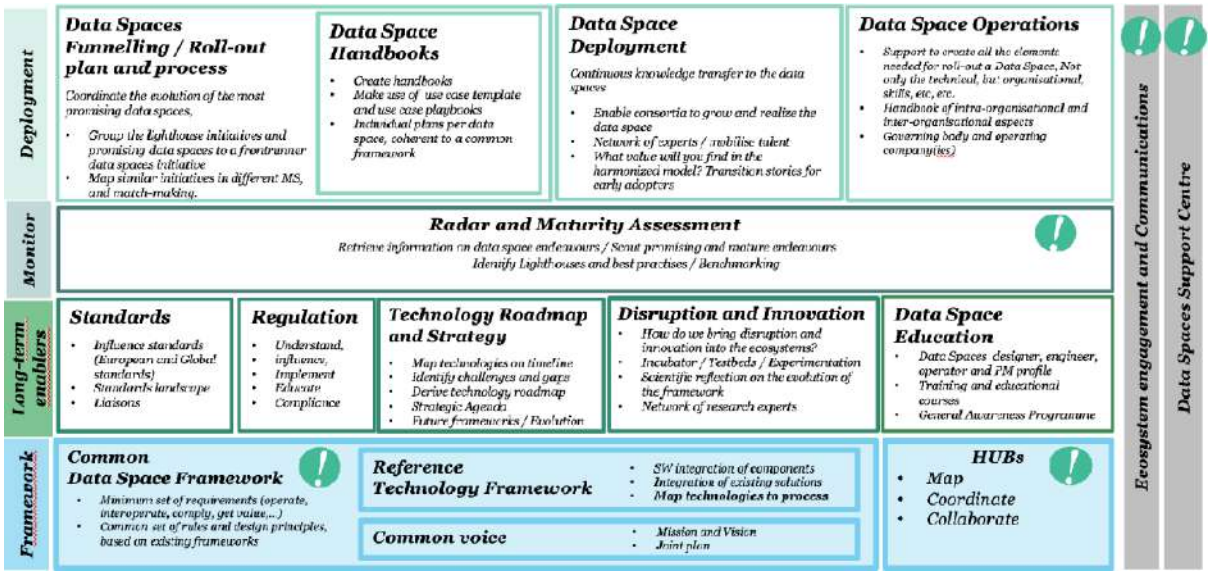

Figure 4 IDSA Implementation Plan towards Data Spaces

Key to establishing data spaces are three foundational technology pillars identified by the DSBA: Data Interoperability, Data Sovereignty and Trust, and Data Value Creation. Central to DSBA's framework is the necessity for a Trust Anchor Framework coupled with a Decentralized Identity and Access Management Framework. This setup ensures a trusted operational environment without reliance on a central intermediary, safeguarding the integrity of data provided by space participants and streamlining user access to dataspace services. This approach enables a more personalized experience in federated marketplaces. The Trust Anchor Framework implements a coherent set of rules, including legislation, standards, and guidelines, agreed upon by various organizations to provide their services securely and reliably.

2.1.7 GAIA-X

GAIA-X defines a Data Space as a virtual integration concept, where participants and their relationships form the foundation, sharing data resources and computing services. These spaces operate within one or across multiple Vertical Ecosystems, maintaining high-level standards for data storage and sharing.

Key design principles of Data Spaces include:

- Data residing in its sources, with semantic integration rather than a common data schema.
- Flexibility for nesting, overlaps, and spontaneous networking of data.
- Enabling spontaneous networking and coexistence of data.

GAIA-X's core values relevant to energy data spaces are summarized as follows:

- Sovereignty, emphasizing self-determination.
- Fairness and adherence to FAIR principles: Findability, Accessibility, Interoperability, and Reusability.
- Inclusivity, ensuring equal access and fostering digital trust.
- Federation, facilitating data exchange, utilization, and control.

Notable outcomes of GAIA-X include:

- The Gaia-X Digital Clearing House (GXDCH), ensuring alignment with GAIA-X standards and fostering trust, sovereignty, and interoperability within the European data ecosystem.

- The GAIA-X Trust Framework, providing rules and mechanisms for stakeholder certification and authentication across decentralized infrastructures.

2.1.8 OPEN DEI

OPEN DEI considers data spaces as a data integration concept, emphasizing semantic integration over common database schemas. These spaces operate within specific application domains based on shared policies and rules, offering a decentralized infrastructure for trustworthy data sharing.

The realization of data spaces requires:

- Data platforms facilitating effective sharing and exchange.
- Data marketplaces for data offering and procurement.
- Data sovereignty infrastructures enabling stakeholders to control their data.

Both technical and governance building blocks are necessary for data space implementation:

- Technical blocks enable architecture implementation, focusing on Data Interoperability, Sovereignty, and Value Creation.
- Governance blocks encompass business, operational, and organizational agreements to regulate data space operation.

Stakeholders in data spaces include data consumers, providers, producers, owners, application and platform providers, and identity providers. Their concerns drive specific requirements, including effective data exchange, agreement enforcement, trustworthiness, and policy support.

The design principles for data spaces include:

- Data sovereignty, ensuring control over data usage.
- A level playing field for fair data exchange.
- Decentralized soft infrastructure and public-private governance for ecosystem development.

These principles are essential for creating trust and fostering innovation in data space ecosystems, addressing concerns related to extensibility, replaceability, and independent evolution.

2.1.9 Considerations from Other Initiatives

ETIP SNET Perspective

ETIP-SNET's perspective of the Digitalization of Energy Action Plan (DoEAP) brings to light the complex digital transformation required in the energy sector. Concentrating on the European Commission's strategic pillars, ETIP-SNET places particular emphasis on the European Framework for sharing Energy Data, Consumer Benefits, and Cybersecurity for their critical role and potential in driving systemic change.

The challenge of creating a European Framework for sharing energy data is met with ETIP-SNET's acknowledgment of the need for comprehensive architectures to address the complexities of energy data management effectively. Although reference architectures have been suggested in the past, ETIP-SNET advocates for a broader strategy to achieve seamless interoperability and prevent isolated data ecosystems. Such architectural foresight is deemed crucial for the adaptive and evolving nature of decentralized energy systems.

Regarding Consumer Benefits, ETIP-SNET supports the development of an all-encompassing data management and governance architecture. This architecture, which emphasizes decentralized, secure, and sovereign data exchange across the value chain, is envisioned to enable seamless integration and standardization within energy data spaces. It promotes a service federation model to ease data sharing and ensure semantic interoperability, aiming to overcome technical challenges while enhancing consumer engagement and creating value.

Energy Data Spaces Projects Cluster

The collaboration among Energy Data Spaces projects, under int:net, focuses on devising a strategic framework and set of recommendations for the creation of a common European energy data space. This collective initiative is dedicated to trialing innovative solutions that will form the basis for the future implementation of the energy data space.

With the varied perspectives and contributions of the Energy Data Spaces Projects towards the energy data space concept and its foundational components, int:net is set to establish a harmonized set of requirements and specifications by:

- Identifying key use cases that span different aspects of data sharing and interoperability.
- Selecting targeted data sets and providers and employing standardized metadata to enhance data discoverability.
- Defining fundamental building blocks, including roles, authentication methods, traceability systems, and protocols for data sharing and reuse.
- Specifying interoperability requirements to underscore their significance.
- Pinpointing key data hubs/platforms essential for the energy data space's success.
- Achieving consensus among stakeholders on governance frameworks and identifying potential investment requirements.

2.2 SYNERGIES Energy Data Space Definition

After the analysis that was conducted and initially reported in Deliverable D2.1 and taking into consideration the conclusions and insights gained through the study of the state-of-play regarding data spaces, SYNERGIES has adopted the following definition:

In SYNERGIES, an Energy Data Space is a **secure and isolated data sandbox environment** that is provided to or is available by each stakeholder (from the energy data value chain and its interrelated, coupled sectors) through different modalities in order to **collect, monitor, control, analyse and share their data in their own terms** and to **obtain, access and use external data (from other data spaces)** through a **reliable, interoperable and sovereignty preserving** approach, effectively enhancing their data-driven intelligence and increasing their data outreach.

3 Definition of Minimum Requirements for the Common European Energy Data Space (CEEDS) in the frame of the int:net activities

3.1 Scope of the activities in the frame of int:net

The scope of activities within the int:net framework focuses on fostering collaboration among sister projects to establish a unified and interoperable Common European Energy Data Space (CEEDS). This collaborative effort aims to address and fulfil the fundamental requirements necessary for the seamless integration, governance, management, and security of data within the energy sector. The activities under int:net are structured to achieve progressive milestones towards this goal, including:

Defining Common Business Use Cases: Initiating the process by identifying and agreeing upon common energy use cases that are pivotal for the energy sector. These use cases serve as the foundation for further detailed analysis and the development of system use cases.

System Use Cases Development: Breaking down the common use cases into more granular system use cases to instruct the development of common building blocks and technical requirements essential for CEEDS.

Holistic Analysis of Use Cases: Providing a holistic view of each use case from both data space-relevant and application (energy)-relevant perspectives. This involves analyzing the need for data exchanges among various energy sector actors, such as DSOs, TSOs, aggregators, and prosumers, and understanding the impact on the resilient operation of electricity networks.

Contribution to Fundamental Requirements: Through collaborative efforts, contributing to the definition of fundamental requirements for CEEDS, with a special focus on data governance, management, interoperability, and security. This includes identifying the minimum requirements for targeted datasets necessary for the effective implementation of identified use cases and the definition of the CEEDS Reference Architecture and Minimum Required Building Blocks.

To achieve to this direction, a series of activities have taken place with the involvement of representatives from int:net, Energy Data Spaces technical partners and relevant stakeholders that promote the proliferation of Energy Data Spaces. Such activities mainly included:

Concertation Meetings and Working Sessions: Organizing a series of concertation meetings and online working sessions involving sister projects and int:net. These gatherings have been designed to facilitate the exchange of ideas, methodologies, and best practices for the uniform elaboration of energy use cases.

Stakeholder Identification and Engagement: Identifying and engaging relevant stakeholders within the energy sector to ensure that the development of CEEDS caters to the diverse needs and challenges faced by different actors, particularly focusing on data sharing, interoperability and data sovereignty issues.

3.2 Elaboration of Common Business Use Cases

In the evolving landscape of the energy sector, the introduction of energy data spaces is set to play a pivotal role, particularly in light of new demand response regulations being formulated under the network code. The collaborative efforts of the EU DSO Entity and ENTSO-E, together with a wide array of European stakeholders, aim to address the growing demand for efficient integration and value optimization across market platforms and demand-side actors. This initiative underscores the sector's shift towards more dynamic and responsive energy management practices, recognizing the need for an enhanced framework to support this transition.

The ongoing reform and evolution of the electricity market design and operation are increasingly focusing on the efficient categorization and management of energy assets. This includes identifying individual units of power generation, energy storage, or demand response modules as key components. Additionally, the concept of grouping these units for joint control is being emphasized, supporting the autonomy of customers in selecting service providers to optimize the flexibility of their assets. This shift aims to facilitate a more organized and efficient deployment of energy resources, contributing to a more adaptive and resilient electricity market.

One of the most significant aspects of the proposed rules is the emphasis on the "switchability" of controllable units between different aggregators or service providers, a move aimed at enhancing consumer sovereignty and market fluidity. This approach not only empowers grid users but also ensures a clear demarcation between hardware ownership and market operations, potentially revolutionizing how energy services are delivered and consumed.

In light of these developments, several business use cases emerged from the common activities of the cluster of sister projects working on Energy Data Spaces, as crucial for harnessing the potential of the Common European Energy Data Space (CEEDS). The Business Use Cases (BUCs) presented below, highlight the need for streamlined digital processes and effective data sharing to support the evolving energy landscape.

- **BUC 1:** Collective self-consumption and optimized sharing for energy communities
- **BUC 2:** Residential home energy management integrating DER flexibility aggregation
- **BUC 3:** TSO-DSO coordination for flexibility
- **BUC 4:** Electromobility: services roaming, load forecasting and schedule planning
- **BUC 5:** Renewables O&M optimization and grid integration

3.2.1 Common Business Use Cases – Detailed description

3.2.1.1 Use case 1: Collective self-consumption and optimized sharing for energy communities.

This use case revolves around the development and management of energy communities, with a keen focus on collective self-consumption and the optimization of energy sharing. The primary aim is to outline the technical setup and economic viability for initiating energy communities, thereby establishing sustainable business models for their operation. This involves introducing mechanisms for detailed data sharing at the device level to facilitate energy flexibility and savings, alongside computing billing costs for both collective and individual activities within the community. This includes energy exchanges among community members and interactions with the electrical grid and other sectors.

The deployment of energy communities on a large scale necessitates careful planning in both the network design phase, determining the size and placement of distributed energy resources, and the operational phase, implementing energy sharing mechanisms within the community. This process is supported by a data space environment that enables the necessary data exchange for optimization scenarios. Here, service providers offer technical algorithms as services to which consumers have subscribed, using technical parameters, pricing, and energy profiles as inputs. The consent for data sharing is managed by the data owners, while outputs received by service consumers include optimal capacity, flexibility schedules, and differentiated pricing for transactions, enhancing forecasts on available flexibility.

The domain of this use case encompasses energy systems, focusing on distribution, decentralized energy resources (DER), and customer premises across operational, enterprise, and market areas.

Key actors of this use case include:

Consumer/Prosumer: Individuals participating in an energy community, contributing to and benefiting from collective energy strategies.

Metered Data Administrator responsible for managing and distributing validated energy consumption data, potentially including data from sub-meters.

Energy Service Company (ESCO) offering energy-related services to consumers or energy communities, including energy management software for local energy communities (LECs).

Energy Trader engaging in the purchase and sale of energy, evaluating the aggregated value of consumers and assets within an LEC.

Market Information Aggregator providing aggregated market information derived from various sources to enhance decision-making.

Resource Aggregator/Flexibility Services Provider aggregating resources for specific services, such as flexibility provision within or for a LEC.

System Operator (TSO/DSO) ensuring the operation, maintenance, and development of the energy system, with a focus on electrical grids.

3.2.1.2 Use case 2: Residential home energy management integrating DER flexibility aggregation.

Use-case 2 focuses on how people using energy at home or in communities can play a key role in making the energy system more flexible and integrated. It looks at using home-based energy resources, like solar panels and batteries, to help manage energy demand, reduce costs, and ease the strain on the energy grid. This involves new digital tools that manage these resources smartly, right where people live.

The future of carbon-neutral homes requires compliance with the "Energy Performance of Buildings" directive. The idea of this use case includes making homes more energy-efficient and giving homeowners up-to-date info on how to use energy wisely and how they can help the grid during high demand or emergencies. This means adding new technologies like smart chargers for electric vehicles and home batteries, all managed through advanced home energy systems.

These systems connect to larger networks, sharing information about energy use and availability. This helps manage energy better across neighbourhoods and cities, making sure everyone has the power they need when they need it, without overloading the system.

The data space for this use case is envisioned to manage all types of distributed energy resources, incorporating the latest in power electronics, edge computing, and data streaming technologies for exchanging residential energy data. This includes data from the main smart meter and any other accessible DER submeters or dedicated measurement devices. The data space will be distributed across federated cloud infrastructures, enabling consent-based data exchanges among actors.

Key actors of this use case include:

Balancing Responsible Parties and Service Providers responsible for their imbalances and providing balancing services, respectively.

Consent Administrators, Data Providers, Market Operators, Metered Data Collectors and Responsibles, Resource Aggregators, Scheduling Agents, Resource Providers, and Prosumers managing consents, data, market operations, meter readings, resource aggregation, and both consuming and producing electricity.

TSOs and DSOs operating and maintaining transmission and distribution systems.

Flexibility Service Providers (FSPs) linking customers with the market and grid, offering demand flexibility.

Weather Forecast Providers and Flexibility Product Qualifiers supporting the prediction and qualification of resources for flexibility services.

Local Energy Management Systems, such as HEMS and BEMS, optimizing the scheduling and dispatch of DERs.

Flexibility Buyers and Settlement Responsibles managing the purchase and settlement of flexibility services.

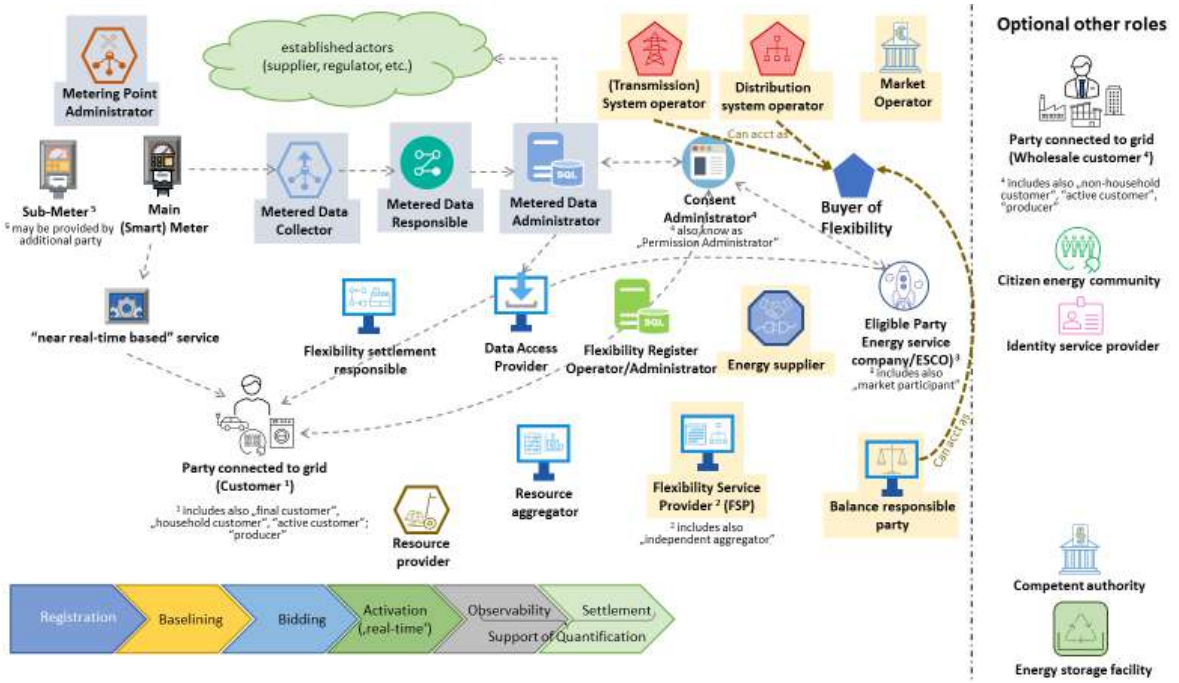

Figure 5 Associated data interactions for the demand-side flexibility

3.2.1.3 Use-case 3: TSO-DSO coordination for flexibility

Use-case 3 explores the vital collaboration between Transmission System Operators (TSOs) and Distribution System Operators (DSOs) to utilize flexibility in a changing energy system marked by decentralization and decarbonization. This partnership aims to enhance the resilience of the energy grid and integrate renewable energy sources efficiently. Addressing the challenges of unpredictable load and generation flows, this use case moves beyond traditional network upgrades, opting for cost-effective, flexible solutions offered by Distributed Energy Resources (DERs).

At the core of this strategy is the implementation of active network management techniques, requiring sophisticated forecasting for resource allocation and real-time grid control. This necessitates a range of analytics to adhere to updated reliability standards and the investigation of market-based alternatives for system services.

The evolving nature of electricity network management demands inclusive market approaches and collaborative operations between TSOs and DSOs to ensure cohesive service delivery and minimize operational costs. Critical to this process is the exchange of data on flexibility needs and operational events, facilitated by energy data spaces to foster effective TSO-DSO cooperation and streamline the deployment of flexibility resources.

Emphasizing the need for innovative, data-centric strategies for the aggregation of flexibility from DERs, this use case highlights the importance of tools enhancing TSO-DSO coordination. Achieving this requires advanced forecasting techniques, flexibility analytics, and tools for collaborative scheduling and dispatch, enabling system operators to accurately forecast flexibility needs, match them with available resources and maintain energy system resilience efficiently.

Key actors of this use case include:

Data Asset Provider offering data, AI models, or analytics results for legitimate sharing or analysis.

Data Asset Owner owning or controlling data, AI models, or analytics results, and may authorize their use by others.

Data Asset Consumer accessing and using data or analytics results owned by others.

Transmission System Operator (TSO) operating, maintaining and developing the transmission system.

Distribution System Operator (DSO) managing, maintaining and developing the distribution system.

Prosumer producing and consuming electricity, potentially providing flexibility services.

DER Owner owning energy resources (e.g., demand, generation, storage) connected to the distribution system, offering flexibility.

Flexibility Service Provider (FSP) engaging in flexibility markets, offering services to TSOs and DSOs, usually an aggregator or DER owner.

3.2.1.4 Use-case 4: Electromobility: services roaming, load forecasting and schedule planning.

Use-case 4 explores the realm of electromobility, focusing on enhancing the charging experience for electric vehicle users (EVUs), optimizing the operation of Charging Point Operators (CPOs), and assisting Transmission System Operators (TSOs) and Distribution System Operators (DSOs) with better charging consumption schedules. The ultimate goal is to offer EVUs a simplified recharging service, help CPOs identify optimal locations for future stations through research access, and equip TSOs/DSOs with predictive charging consumptions based on historical data. Moreover, it aims to provide EVUs with intelligent route planning that maximizes charging point utilization and network efficiency.

In this scenario, an EVU looking to book a charging slot interacts with an E-Mobility Service Provider (eMSP) through an app or platform, where they can view available infrastructure, reserve charging points, and compare rates. The user can make a reservation by providing necessary details, leading to an estimated charge cost. Post-charging, the user receives a detailed invoice and is charged accordingly. This use case also emphasizes the need for standardization across Europe to unify CPO services, making them accessible to all EVUs.

Key actors of this use case include:

Charge Point Operator (CPO) managing EV Charging Infrastructure, optimizing charging session costs and revenues.

e-Mobility Service Provider (eMSP) offering services related to EV use, requiring subscription and accessible via an app.

Electro Mobility Roaming Service Provider (EMRSP) providing universal intermediation between CPOs and eMSPs, facilitating service access.

Electric Vehicle User (EVU) using the vehicle and/or influencing charging patterns with their driving needs.

3.2.1.5 Use-case 5: Renewables O&M optimization and grid integration

Use-case 5 targets enhancing renewable energy's competitiveness and integration into the smart grid. It focuses on improving the operation and maintenance (O&M) of renewable assets using advanced algorithms and data analytics, leveraging a broad range of data for better fault detection, maintenance, and grid integration. This approach aims to reduce the Levelized Cost Of Energy (LCOE) and address grid challenges like congestion and voltage volatility by optimizing renewable resource deployment.

Data spaces play a crucial role by breaking down data silos, enabling access to diverse data sets for better algorithm generalization and innovation in renewable energy services. Encouraging data exchange among stakeholders is essential for developing solutions that not only optimize renewable asset O&M but also ensure data security and privacy.

Key actors of this use case include:

RES Plant Owner owning the renewable energy source (RES) power plant, providing crucial operational data.

RES Plant Operator managing the RES power plant, potentially distinct from the owner, contributing operational data.

OEM (Original Equipment Manufacturer) supplying key equipment for the renewable power plant.

TIER2-3 Component Manufacturer producing specific renewable power plant components, offering specialized services.

Data Analytics Service Providers delivering value-added services by analyzing data from various providers, including ICT companies, research institutions, and academia.

Prosumer capable of both producing and consuming energy, playing a dual role in the energy ecosystem.

Consumer/Producer engaging in energy consumption or production, offering insights into energy use and generation patterns.

DSO (Distribution System Operator) ensuring the efficient distribution and integration of renewable energy within the grid.

3.2.2 Definition of use cases Fundamental Requirements

Based on the analysis of the business use cases in the previous section, we can identify a set of fundamental requirements that emerge across these use cases. These requirements are essential for supporting the development, management, and operational effectiveness of energy communities, home energy management systems, TSO-DSO coordination, electromobility services, and renewables O&M optimization. These fundamental requirements pertain to:

- Interoperability and Standardization: Ensuring systems, data formats, and protocols can work together seamlessly across different energy sectors and technologies.
- Data Sharing and Privacy: Implementing secure and consent-based mechanisms for sharing data while protecting user privacy and adhering to regulatory requirements.
- Scalability: Designing systems and solutions that can efficiently scale to accommodate growth in energy communities, DERs, and service users.
- Flexibility and Real-time Operations: Facilitating dynamic management of energy resources and services to respond to real-time demand, supply fluctuations, and grid stability needs.
- Distributed Energy Resource (DER) Integration: Efficiently integrating and managing various DERs, including renewables, storage, and home energy systems, within the energy grid and communities.
- Energy Efficiency and Optimization: Leveraging advanced algorithms, data analytics, and machine learning to optimize energy use, reduce waste, and enhance overall system efficiency.
- Economic Viability and Business Models: Establishing sustainable business models that encourage the adoption of energy communities, DERs, and new technologies while ensuring economic benefits for all stakeholders.

- Regulatory Compliance and Standards Adherence: Ensuring all solutions and practices comply with existing regulations, standards, and directives related to energy, buildings, and environmental protection.
- User Engagement and Participation: Encouraging active participation of consumers, prosumers, and other stakeholders through user-friendly platforms, incentives, and transparent communication.
- Advanced Forecasting and Analytics: Utilizing weather, consumption, and production data to enhance forecasting accuracy for energy production, demand, and grid management.
- Infrastructure and Network Management: Developing robust infrastructure and network management solutions to support the integration of DERs, electromobility, and energy efficiency initiatives.
- Security and Resilience: Ensuring the energy system's security and resilience against cyber threats, physical disruptions, and other vulnerabilities.

3.3 Elaboration of Common Minimum Required System Use Cases

To effectively implement the five business use cases (BUCs) outlined for the Common European Energy Data Space (CEEDS), it's essential to establish a coherent and interoperable framework that spans across various data space functionalities, ensuring seamless onboarding, data/service metadata interaction, contracting, and data exchange interoperability among different data spaces. Such a framework has been analyzed and broken down into a bundle of four (4) System Use Cases (SUCs) considered as the minimum and fundamental use cases for the realization of a Common European Energy Data Space (CEEDS).

3.3.1 Onboarding (SUC1)

This foundational use case necessitates a secure and streamlined process for various actors (Service/Data Owners and Users) to join the data space. It involves creating and publishing Digital Identity Documents (DIDs), undergoing an accreditation process, and receiving verifiable credentials. This process is pivotal in establishing trust and ensuring secure participation within the data space.

3.3.2 Data Discovery and Cataloguing (SUC2)

For the data space to function effectively, it must facilitate the discovery and cataloguing of data and services. This includes the creation, validation, and storage of self-descriptions for data and services, enabling participants to easily find and utilize the resources they need. This use case underscores the importance of interoperable standards and protocols for data sharing and discovery.

3.3.3 Contracting (SUC3)

The contracting use case is central to formalizing the exchange of data and services within the data space. It involves listing available offers, validating contracts, and initiating data transfers, ensuring that transactions are carried out securely and in accordance with agreed-upon terms. This process is crucial for maintaining the integrity and accountability of data exchanges.

3.3.4 Data Exchange and Interoperability (SUC4)

SUC4 tests data exchange interoperability across different Energy Data Spaces by enabling a data consumer from one space to discover, contract, and exchange data with a data owner in another, thereby utilizing the dataset for their local services. This use case extends SUC3's contracting process across distinct data spaces.

3.4 Minimum Building Blocks and High-level Architecture for a Common European Energy Data Space

The concept of Common European Energy Data Spaces (CEEDS) is envisioned to revolutionize the exchange of energy-related data by leveraging a network of interconnected data spaces. These data

spaces, underpinned by foundational agreements on software building blocks, APIs, and interoperability standards, aim to facilitate regulated and efficient data exchange within the energy sector. By utilizing data and services indexed in data space catalogues (by stepping on and utilizing the services addressed through the common SUCs), the scenarios depicted in the Business Use Cases (BUCs) aim to operationalize energy services, thus broadening the participation of various actors in energy system operations. This participation is anticipated to yield significant benefits, including monetary savings, enhanced service quality, and improved reliability in electricity distribution.

The architecture of the CEEDS will not be built from scratch but will expand and refine the existing isolated data exchange ecosystems to create a cohesive infrastructure that supports seamless and fair data sharing. This is envisioned through the integration of "distributed data ecosystems" (existing legacy data platforms) with a "federated data space," forming a unified energy data space. This model is inspired by the Data Exchange Reference Architecture 3.0 (DERA 3.0), outlined by the BRIDGE Data Management Working Group, which details the local and federated components of this architecture.

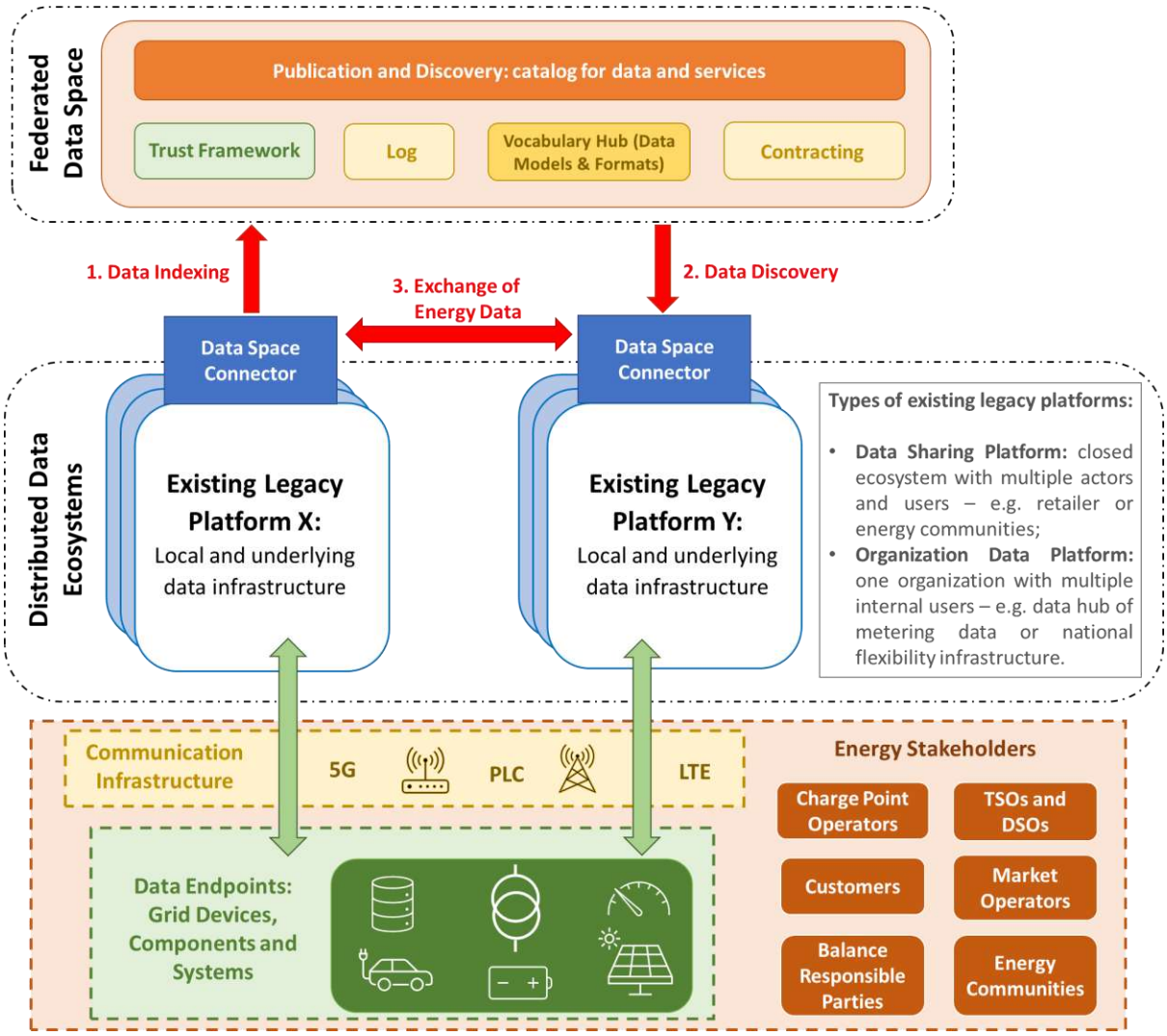

Figure 6 Exchange of energy-related data among different data legacy platform (as data spaces actors).

The "distributed data ecosystems" represent the various existing data platforms managed by individual or groups of actors within the energy market. Incorporating a data space connector into these platforms will facilitate their integration into the federated data space, enabling them to share and access data across the ecosystem. This approach supports the exchange of data among different

participants linked to diverse legacy platforms, enhancing the efficiency and effectiveness of energy-related operations.

On the other hand, the "Federated Data Space" serves as a central indexing and marketplace for data and services, allowing for the discovery and trade of data among multiple actors and platforms through the data space connectors. This federated layer is crucial for establishing a dynamic and flexible energy data ecosystem that supports a wide range of energy services and applications.

Through this integrated approach, the CEEDS aims to foster a collaborative and interoperable environment that not only facilitates the exchange of energy-related data but also promotes innovation and efficiency in the energy sector. The architecture's emphasis on secure, standardized, and equitable data sharing practices underscores the potential of CEEDS to transform energy system operations and contribute to the sector's digitalization and sustainability goals.

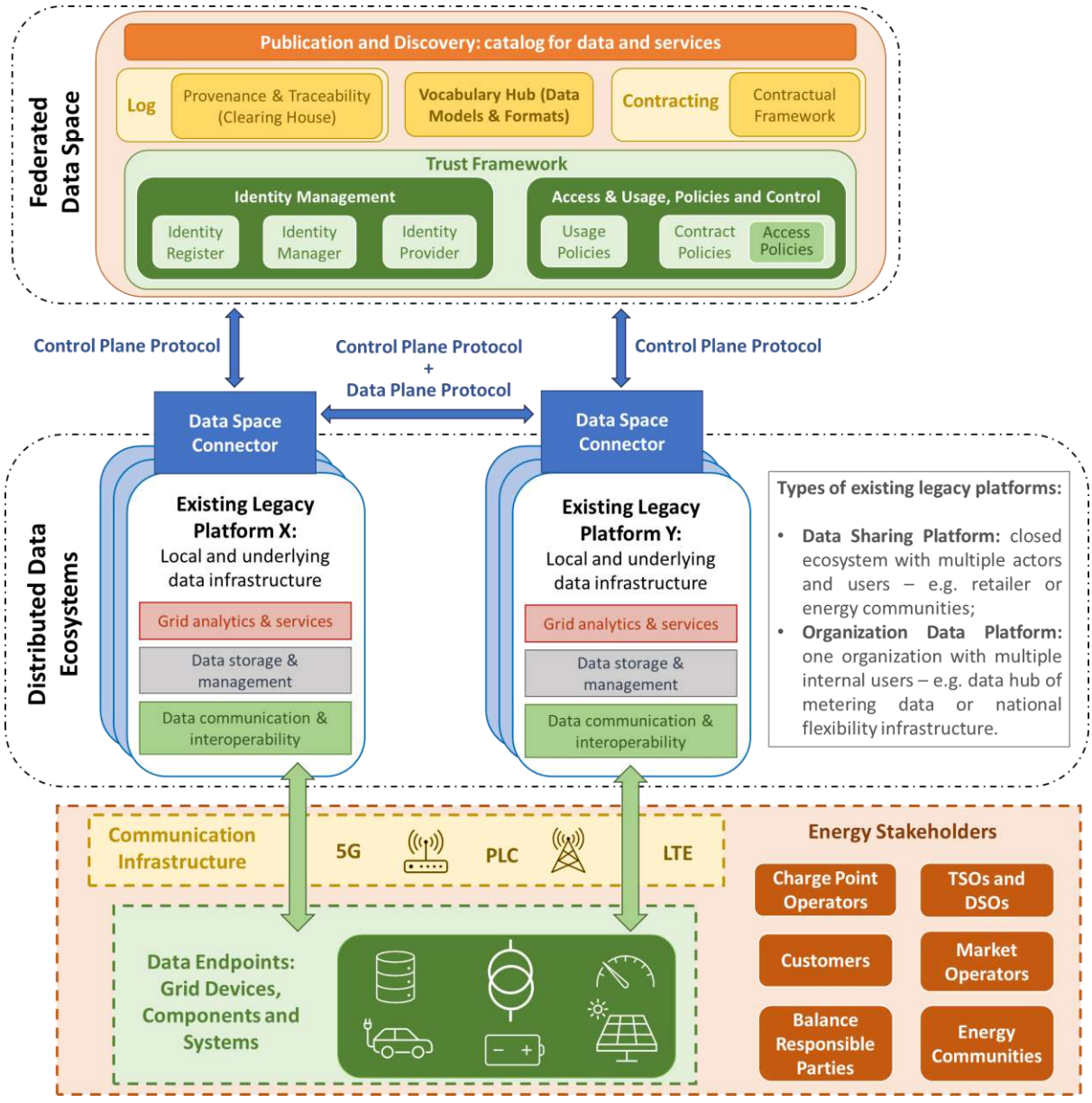

Figure 7 CEEDS Reference Architecture

The core reference architecture of the Common European Energy Data Space (CEEDS), presented in figure 7, includes several key Building Blocks, each tailored to facilitate a seamless and secure data exchange within the energy sector. These Building Blocks are designed to enable a diverse array of

applications, from enhancing renewable energy asset management to supporting electromobility and smart grid initiatives.

These building blocks include:

Trust Framework

- Associated with "Access & Usage Policies and Control" and "Identity Management".
- Ensures data sovereignty, allowing control over access and usage of data through interoperable policies.
- Comprises access policies (conditions to access services and data) and usage policies (specifying rights and obligations for data use).

Log

- Linked to "Provenance & Traceability".
- Logs information about data usage and incidents, crucial for billing, conflict resolution, and ensuring traceability and provenance in data transactions.

Vocabulary Hub

- Facilitates seamless communication with data space connectors and infrastructure components.
- Stores and provides access to standardized terms and their descriptions, ensuring data and service discovery complies with established vocabularies.

Contracting

- Associated with "Contractual Framework".
- Encompasses contract templates and model clauses, enabling the management and execution of data transactions.
- Integrates tools for automating the contracting process, enhancing the legal validity and efficiency of agreements.

Publication & Discovery

- Acts as a catalogue for self-descriptions of data products, making them discoverable for potential users.
- Manages self-descriptions, enabling dynamic transactions and access control to ensure loose coupling between data providers and users.

To ensure the successful deployment of the Common European Energy Data Space (CEEDS), incorporating interoperability measures is pivotal. These measures span three crucial areas: technical interoperability, semantic interoperability, and governance interoperability.

Technical Interoperability focuses on establishing a foundational framework allowing all data space participants to process, understand, and exchange service and data metadata effectively. This framework includes defined building blocks, standardized roles for participants, uniform data formats, and data transmission protocols. A "data space connector" plays a key role by serving as the interface for participants, supplemented by shared registries and services for tasks like participant registration.

The Building Blocks are categorized into three main groups: data interoperability (for data exchange), data sovereignty and trust (for identifying participants and managing data access and usage), and data value creation (for enabling marketplace functionalities and data monetization). The distinction between the control plane (managing data routing and policy enforcement) and the data plane (handling the physical data movement) is essential for achieving a flexible and comprehensive interoperability model.

Semantic Interoperability ensures that diverse systems can exchange and interpret information consistently, facilitated by harmonization frameworks that establish common vocabularies, data

models, and ontologies. This shared semantic context is crucial for integrating and interpreting data across the smart grid ecosystem seamlessly.

Governance Interoperability addresses the overarching structure and decision-making processes within the data space, encompassing everything from a common European framework for data ecosystems to specific governance for soft infrastructure. It aims to promote cross-stakeholder collaboration and ensure convenient, compliant data access and exchange.

3.5 Overview of Activities

The table below showcases SYNERGIES' active involvement in the collaborative activities conducted under the hood of the int:net Support Action, up to Month 18 of the project.

Title	Date	Summary of Activities	Participation Type
int:net – Concertation Meeting	30/9/2022, Brussels	○ Presentation of int:net and all energy Data Space projects. ○ Discussion on the most important issues that collaboration shall focus on.	Physical participation in meeting
int:net - ENLIT Workshop	30/11/2022, Frankfurt	○ Presentation of int:net and all energy Data Space projects. ○ Panel discussion focusing on data sharing and consumer engagement issues and on the ways Data Spaces can support and facilitate them.	Physical participation in meeting
int:net - Use Case Workshop	16/1/2023	○ Presentation of the scope of the activities referring to collaborative use case elaboration. ○ Presentation of the proposed template and request for feedback/ comments by the different projects	Remote participation in meeting
int:net Use Case Elaboration	3/2/2023	○ Provision of feedback/ comments on the use case template shared by int:net. ○ Strong suggestion to align with IEC 62559 standard	Contribution
int:net - Energy Data Spaces Projects Cluster - Meeting with EC - Preparatory activity	2/5/2023	○ Emphasis on achieving a common view among stakeholders regarding the goals and direction for the Common European Energy Data Space (CEEDS), highlighting the necessity for concrete outputs and specific guidelines. ○ Identification of coordination content as crucial, including priority use cases, target data sets, common building blocks, and interoperability aspects, to ensure cohesive development and implementation across projects.	Remote participation in meeting
int:net - WP1: webinar on interoperability survey	22/5/2023	○ Collect information about ongoing interoperability projects, including the energy data space projects ○ Analyse the existence of common or mismatching interoperability aspects through an architecture approach such as ISO/IEC/IEEE 42010.	Remote participation in meeting

Title	Date	Summary of Activities	Participation Type
		○ Highlight potential synergies that could be turned into policies, roadmap, or standardization.	
int:net Cluster event on Energy Data Spaces	13/9/2023, Brussels	○ Spotlight on selected national lighthouse projects ○ Way to leverage progress of these initiatives and what synergies could be demonstrated with projects of the European Cluster on 'Building the grounds for an Energy Data Space'	Physical participation in meeting
int:net Energy data spaces projects cluster	24/10/2023	○ Recap from last meeting with EC (13th Sept, Brussels) ○ Technical baseline (building blocks) for the defined reference use cases ○ Preparation for cluster workshop	Remote participation in meeting
int:net Energy data spaces projects cluster workshop	8/11/2023, Bilbao	○ Define the system use case to demonstrate the interoperability amongst sister projects ○ Fulfil the commitment with the European Commission	Physical participation
int:net Updated contributions on use cases	27/11/2023	○ Updated contributions on use cases ○ Revision of the introductory part of the document, covering the discussion topics during the meeting in Bilbao	Contribution
int:net Identity management (SYNERGIES & EDDIE)	27/11/2023	○ Presentation of Identity Management approaches followed in Enershare and SYNERGIES ○ Bilateral discussion on how to achieve cross-data space interoperability regarding onboarding and identity management ○ Possibility to end-up with a set of specifications for a proof-of-concept rather than actual demonstration	Remote participation in meeting
int:net Energy data spaces projects cluster	28/11/2023, ENLIT (Paris)	○ Dedicated Energy Data Spaces Session and Panel Discussion addressing Key Challenges for Energy Data Spaces	Physical participation in meeting
int:net System Use Cases refinement workshop	5/12/2023	○ Refine the SUCs based on comments and findings from cluster projects ○ Preliminary Agreement of data flows between the components involved	Remote participation in meeting
int:net System Use Cases refinement workshop	14/12/2023		Remote participation in meeting
int:net CEEDS - SUC1- Onboarding	12/1/2024	○ Technical follow up on interoperability between data spaces addressing the onboarding and identity management features ○ Elaboration on Global Identity Management Options	Remote participation in meeting

Title	Date	Summary of Activities	Participation Type
int:net Energy data spaces projects cluster	24/1/2024	○ Blueprint of Common European Energy Data Spaces (CEEDS) ○ Presentation of the draft version ○ Agreement on modification/ extensions ○ Updates on ongoing cluster activities	Remote participation in meeting
int:net CEEDS - SUC1- Onboarding Workshop	6/2/2024	○ System Use Case 1 follow up call) ○ Workshop to start drafting the common approach for IAM	Remote participation in meeting
int:net CEEDS - SUC1- Onboarding – HUAWEI/Identity Bridge Contributions	19/2/2024	○ Questions towards Huawei regarding Identity Bridge ○ Determine if it can function as an overlay identity management system across data spaces	Contribution

Table 1 SYNERGIES involvement in activities in the frame of int:net

4 Interoperable Data Exchanges Validation between Sister Projects' Data Spaces

4.1 Validation and Testing Approach

As part of the activities performed in the frame of int:net and the collaboration established between sister projects (also consisting in one of the activities to be implemented under WP7 of SYNERGIES) is the demonstration and validation of interoperable data exchanges between the energy data spaces implementations performed in each of the sister projects, namely SYNERGIES, OMEGA-X, EDDIE, ENERSHARE and DATA CELLAR.

To this end, all sister projects have elaborated on the bundle of System Use Cases described in the previous sections, which point to the fundamental features and functions that an Energy Data Space shall satisfy. In this context, these use cases have been selected to demonstrate and validate the interoperability between the different Energy Data Spaces, both at an individual level (SUCs 1-3) and in a consolidated manner, through the demonstration of SUC 4 that acts as an umbrella over all other SUCs and aims at validating the end-to-end interoperable data exchanges, including interoperability aspects involved in the Onboarding (SUC 1), data discovery (SUC 2) and contracting (SUC 3) processes.

As part of the preparatory activities for the actual demonstration (that will take place after Q1 of 2024), the cluster of sister projects have launched the detailed elaboration of the SUCs, in order to commonly define the workflows that need to be implemented, identify bottlenecks and define technical details and considerations that need be addressed, prior to the actual validation in operational environments offered by the sister projects.

The following paragraphs present a detailed overview of the progress achieved so far to achieve the convergence between the different implementations of the sister projects. More detailed elaborations and results of the validation activities will be reported in D7.2 of SYNERGIES (due in M42 of the project), once the validation activities have been performed and relevant findings and conclusions have been drawn.

4.2 System Use cases elaboration and progress overview

4.2.1 SUC 1: Onboarding

The focus of System Use Case 1 revolves around formulating a strategic approach to Identity and Access Management (IAM) within the Energy Data Space initiatives. Key considerations include:

- **Adoption of a Unified IAM Framework vs. Enhancing Interoperability among Existing Systems**: Determining whether to standardize IAM across all projects or to ensure existing IAM systems can work together seamlessly.
- **Architectural Adaptability and Proof of Concept (PoC):** Evaluating if projects can adjust their existing architectures to accommodate new IAM strategies or if a PoC is necessary to test these integrations.
- **Software Component Identity:** Discussing the importance and implications of assigning identities to software components to simplify interactions and enhance security.
- **Global Identity Provider Integration:** Exploring the implementation of a global identity provider that could "interoperate" with the identity providers specific to individual projects, aiming for a cohesive IAM ecosystem across the data space.
- **Path to Self-Sovereign Identity (SSI):** Investigating the adoption of DIDs and the standards currently utilized (e.g., OAuth, OpenID Connect, DIDs, VC/VP) to move towards an SSI model, including the analysis of existing issuers and verifiable data registries.
- **Interoperability Requirements:** Identifying which entities need to be interoperable across different projects to ensure a smooth and efficient data exchange and management process.

- **Added Value for Participants:** Conceptualizing the benefits and enhancements that a common IAM approach would bring to participants across various projects, potentially through user journey mapping.

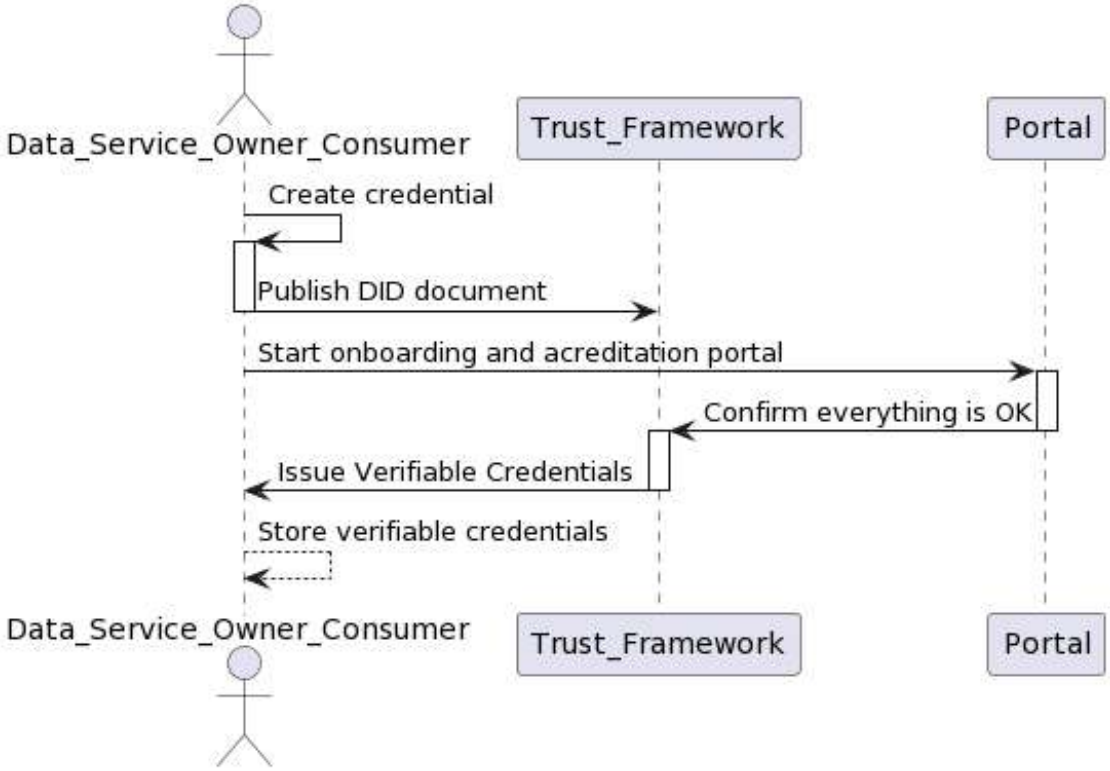

Figure 8 UML Diagram for SUC 1: Onboarding

Out of the various workshops that have taken place with the involvement of all sister projects, it was made obvious that a global identity management solution might facilitate the interoperable onboarding across all different data spaces. At the moment, several options are considered and are under assessment for the establishment of this global identity management framework (Identity Bridge configuration) to allow for the unified management of credentials without introducing any significant redesign and reconfiguration need on the side of the different projects' implementations.

4.2.2 SUC 2: Data Discovery and push into the catalogue

This use case, operating under the framework of the Minimum Viable Data Space (MVD), focuses on streamlining data sharing and discovery within the Energy Data Space projects. This step follows the foundational SUC1, where all actors are assumed to have completed the initial onboarding process. SUC2 introduces the procedure for integrating data assets into the data space, facilitated through two primary methods:

- Direct submission via API for automated, machine-client interactions.
- Manual entry through the Data Space Portal, catering to human end-users.

The essence of SUC2 lies in generating and storing self-descriptions of data assets in the catalogue, complemented by additional metadata, to foster an interoperable and unified data sharing ecosystem. This phase is crucial for enhancing data discovery, ensuring that the catalogue's contents are reflective of the diverse data assets available within the ecosystem.

Two options delineate the sequence diagrams for component interactions within SUC2:

- Option 1 focuses on direct interactions between Participants and the Catalogue, simplifying the data discovery process.

- Option 2 expands to include Participants, Catalogue, Portal, and OCM, offering a more comprehensive approach to data handling and discovery within the data space.

Discussions among the Energy Data Space Cluster around SUC2 also delve into essential considerations for data space implementation, such as:

- The adoption of credentials for describing entities within the data space, thus facilitating cross-project and cross-domain interoperability.
- Addressing privacy concerns related to metadata discovery, proposing strategies to balance the visibility of sensitive metadata while enabling broader data space connectivity and discovery.
- Deciding on catalogue implementations to support diverse project requirements and compliance goals, with a collective movement towards public service exposure for early interoperability checks.

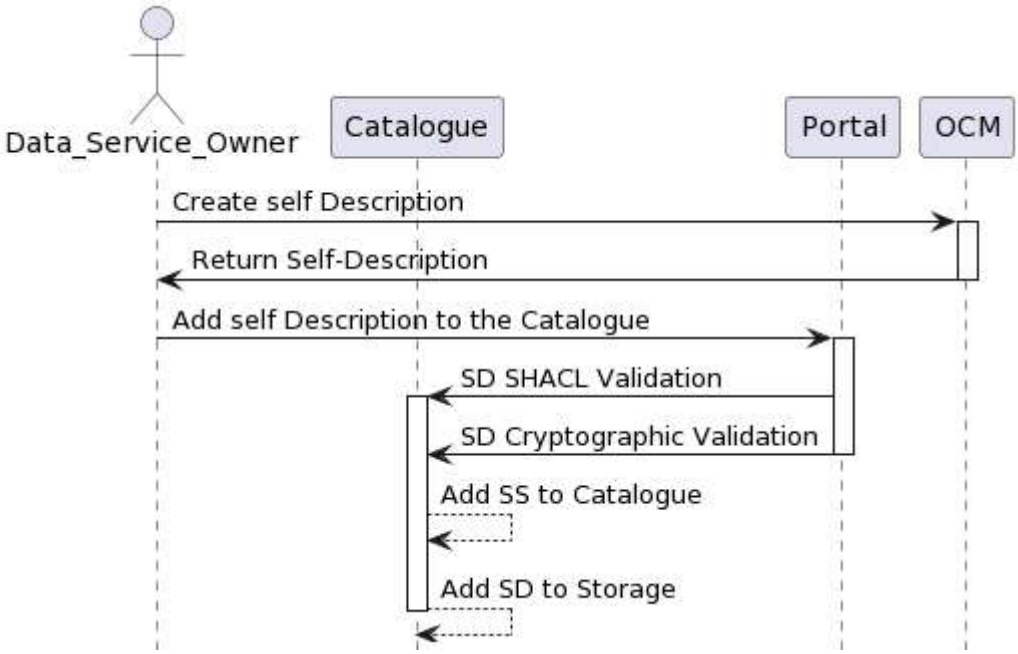

Figure 9 UML Diagram for SUC 2: Data Discovery and push into the catalogue

4.2.3 SUC 3: Contracting

In the context of Use Case 3, which focuses on the process of contracting within Energy Data Spaces, all participating projects in the Energy Data Spaces Cluster reached a consensus on leveraging the IDSA Data Space Protocol as a foundational guideline to support interoperability, specifically for contracting functionalities.

Ongoing discussions culminated in several critical alignments to streamline interoperability:

- Actors essential for minimal interoperability were identified and agreed upon, streamlining the interaction process.
- Module terminology was harmonized in line with the Data Space Protocol, ensuring consistency across projects.
- A strategic decision was made to adopt a simplified specification, allowing for project-specific adaptations and flexibility.

Two distinct approaches to the contracting process were outlined for further analysis:

- Option 1: Direct interaction of Connectors with a central contracting module in the data space.

- Option 2: Bilateral negotiation of contracts directly between two connectors.

The discussion underscored that these steps, while laying the groundwork for technical interoperability, are part of a broader journey toward comprehensive interoperability. Future efforts will need to extend beyond the technical domain to include semantic alignment, use case integration, policy coherence, and other critical dimensions.

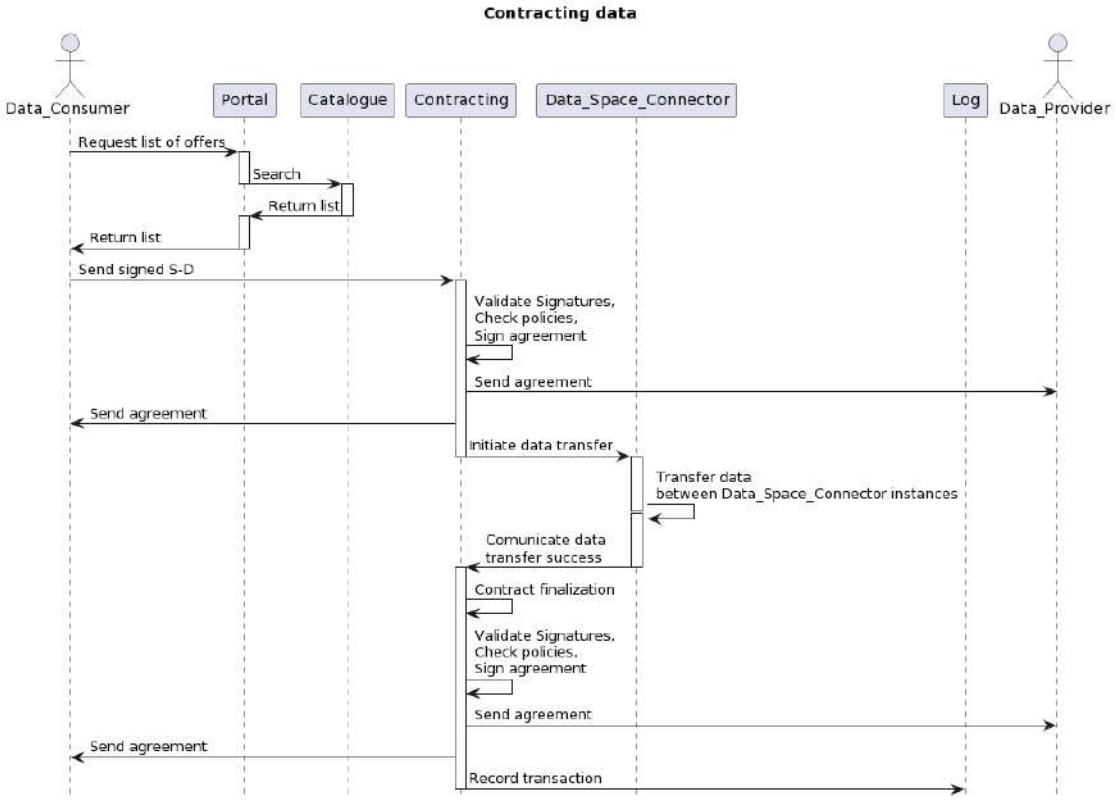

Figure 10 UML Diagram for SUC 3: Contracting

4.2.4 SUC 4: Data Exchange and Interoperability

This SUC involves the actual exchange of data between different data spaces, ensuring interoperability across diverse platforms. It encompasses onboarding in a new data space, discovering and contracting data sets or services, and transferring data securely between providers and consumers. This use case emphasizes the need for flexible, scalable, and secure data exchange mechanisms that can adapt to various operational requirements and regulatory standards.

More detailed discussions on the use case implementation are planned after the deployment of the different data spaces and once all previous system use cases have concluded to concrete approaches for their actual validation.

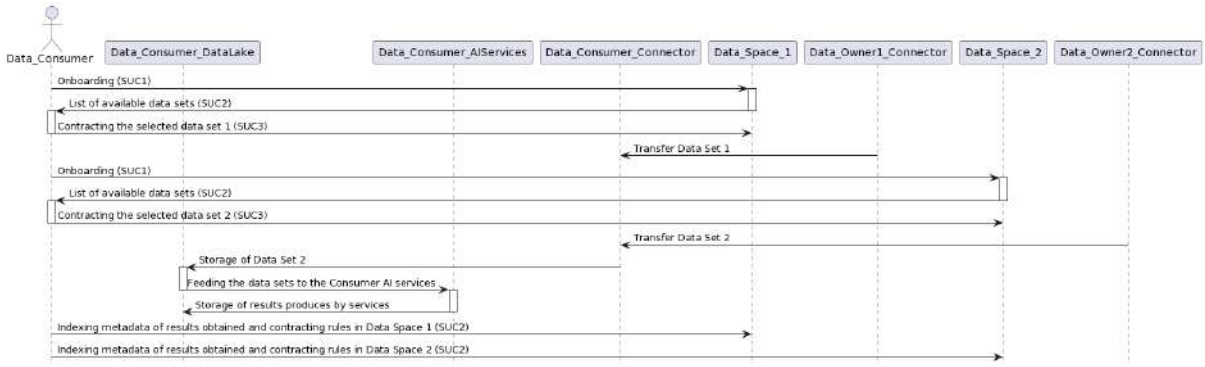

Figure 11 UML Diagram for SUC 4: Data Exchange and Interoperability

4.3 Energy Data Spaces testing and verification timeplan

The work concerning the demonstration of interoperability among Energy Data Spaces is an ongoing process. There exists a consensus within the Energy Data Spaces cluster regarding the methodologies for implementing the various system use cases. These agreed-upon approaches serve as the groundwork for future discussions and analyses aimed at enhancing the interoperability of data spaces.

The timeplan that has been agreed for the Joint Demonstration of Interoperability (Block D of the cluster activities) is presented in the following figure:

	Year	2023						2024											2025			
	Month	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
Block C - Building the federated data spaces																								
Definition and characterization of reference use cases for Common European Energy Data Space (CEEDS)																								
Alignment of data spaces pilots: semantic and technical (e.g., architectures, building blocks) interoperability requirements									R4								R5							
Block D - Joint demonstration for interoperability																								
Defining MVP for the federated data spaces											R6													
Alignment of data spaces pilots: interopeability of building blocks																								
Consolidated learning from federated energy data spaces (aligned with EU regulations)																								R7

Figure 12 Planning of the cluster activities for the Joint Demonstration and Validation of Interoperability (Block D)

Detailed insights and developments on this topic are anticipated to be covered in the subsequent deliverable D7.2 [11] – Final Report on Interoperability Demonstration and Liaison activities on M42.

5 Contribution to the definition of an interoperability testing framework

Aiming towards defining a comprehensive interoperability testing framework, a pivotal step undertaken by Int:net involved circulating a detailed survey aimed at gathering insights from ongoing interoperability projects, with a significant focus on those within the energy data space domain. This survey was designed with the objective of uncovering both the shared and divergent aspects of interoperability as encountered by various projects, thereby leveraging an architecture-centric approach aligned with the ISO/IEC/IEEE 42010 standards.

By meticulously analyzing the responses from this wide array of projects, the survey seeks to uncover the underlying patterns and discrepancies in interoperability practices. This analysis is crucial for identifying areas where collaborative efforts could yield substantial advancements in the interoperability domain. Specifically, the survey aims to pinpoint potential synergies among the projects that could be harnessed to develop policies, outline a strategic roadmap, and guide standardization efforts in the realm of interoperability testing.

The comprehensive nature of this survey is instrumental in achieving a holistic view of the interoperability landscape. It not only captures the technical, semantic, and governance facets of interoperability but also considers the practical applications and challenges faced by projects in implementing interoperable solutions.

5.1 Interoperability Survey – 1st Phase

The first phase of the survey conducted by the Int:net project focused on gathering initial insights and establishing a baseline for interoperability within the Common European Energy Data Space (CEEDS) projects, including SYNERGIES among others. This preliminary survey aimed to understand the projects' approaches to interoperability, their initial use cases, and the frameworks or models they intended to apply for interoperability. The survey questions initially aimed to identify:

- General project descriptions and objectives.
- Early identification of shared data and interoperability needs among sister projects.
- Initial proposals for Interoperability of Operations (IoP) frameworks and cases.
- Preliminary thoughts on IoP construction and profiles.

The survey targeted coordinators and technical leads of the CL5-2021-D3-01 projects, including but not limited to Data Cellar, Eddie, Enershare, Omega-X, and SYNERGIES. These individuals were chosen for their comprehensive understanding of their projects' goals, interoperability challenges, and strategies for addressing these challenges.

At the moment that the survey was conducted, SYNERGIES was in the final stages of its design phase, focusing on finalizing the Use Cases, Requirements, Technical Specifications, and Architecture for the Energy Data Space. In this context, specific contributions were provided addressing the enhancement of semantic interoperability by creating a Network of Sectorial Data Models that are managed through a dedicated Data Model Management component, ensuring that diverse data sources can be harmonized and integrated seamlessly.

SYNERGIES has, also, outlined several key use cases that demonstrate the project's goals:

- Ensuring seamless semantic interoperability within energy data spaces.
- Managing the lifecycle and integration of a network of sectorial data models.
- Simplifying data ingestion pipeline configuration and improving data health.
- Ensuring privacy and security in data sharing and facilitating efficient data search and self-service across cloud and federated data spaces.

These use cases extend to Data-Driven and Intelligence-Enabled Energy Services, focusing on analytics for prosumer behavior, energy demand and generation forecasting, flexibility analytics, and support for network operation planning, among others. These applications aim to optimize energy management at various levels, from individual buildings to entire communities, and to enhance coordination between TSOs and DSOs.

Regarding semantic interoperability challenges, SYNERGIES acknowledged the need for the elaboration of an advanced harmonization approach to align cross-sectorial data models effectively, rather than only leveraging single ontologies and models, and put forward the need for further elaboration of the SGAM model to provide common semantic harmonization mechanisms for facilitating information exchange across extended value chains. In alignment with the envisaged European Interoperability Framework. SYNERGIES brings forward an open standards-based data model harmonization framework to reconcile incompatible semantic models under a unified approach. This includes the development of sector-specific data models for the energy, buildings, and mobility sectors, which will be managed and integrated within the SYNERGIES Network of Sectorial Data Models. The technical aspect of interoperability in SYNERGIES includes the delivery of open connectors, such as IoT Connector, Modbus, and OPC-UA, to establish unified data exchange interfaces with IoT and legacy systems.

5.2 Interoperability Survey 2nd phase

While the first phase set the groundwork for understanding the interoperability landscape across the sister projects, it was recognized that a more in-depth analysis and implementation details would be needed as the projects progressed. Therefore, the second phase of the survey was planned as a follow-up to delve deeper into the actual implementations, use case developments, and refined interoperability frameworks based on the initial findings and project evolutions. SYNERGIES effectively contributed to the 2nd phase of the interoperability survey, by providing detailed information on how BUC 3 (TSO-DSO Coordination for Flexibility) is going to be realized within the project, providing in-depth details regarding the various components involved, the data flows performed between involved actors and systems, the mapping of the BUC 3 into the SYNERGIES architecture and the interoperability stacks employed to facilitate seamless and interoperable data exchanges.

5.3 Overview of activities

The table below presents an overview of the SYNERGIES' relevant contributions conducted in the frame of int:net, up to Month 18 of the project.

Title	Date	Summary of Activities	Participation Type
int:net Interoperability survey contributions – 1st Phase	4/8/2023	○ Contributions regarding the Architecture and profiles namely in sections Interoperability Case and Interoperability Construction	Contribution
int:net Interoperability survey contributions – 2nd Phase	20/2/2024	○ Contribution to Use Case Analysis (Based on Blueprint of CEEDS) ○ Analysis of System Construction ○ Elaboration Interoperability and Data Exchange (IoP Construction)	Contribution

Table 2 SYNERGIES contributions to the int:net Interoperability Survey

6 Elaboration of DERA 3.0

SYNERGIES involvement in the BRIDGE initiative, particularly within the Data Management Working Group, marks a significant chapter in the consortium commitment to advancing the energy sector's digital transformation. The active participation in the Data Management Working Group has allowed SYNERGIES to contribute to the foundational elements of the Data Exchange Reference Architecture (DERA) 3.0.

6.1 Engagement in DERA 3.0 Elaboration

Within the BRIDGE Data Management Working Group, SYNERGIES played an active role in shaping the specifications for the release of the Data Exchange Reference Architecture (DERA) 3.0. Leveraging our project's initial specifications, we contributed insights and expertise during the early stages of implementation. Additionally, we extended our commitment to enriching the Use Cases repository hosted in the EIRIE platform, ensuring essential information was provided to support the realization of use cases involving CEEDS and data exchanges. Furthermore, SYNERGIES made significant contributions to the BRIDGE General Assembly Meeting in March 2023 (Brussels), where we presented high-level use cases and engaged in discussions surrounding the foundational building blocks of Energy Data Spaces, during the "Setting up a common European data space for energy" session.

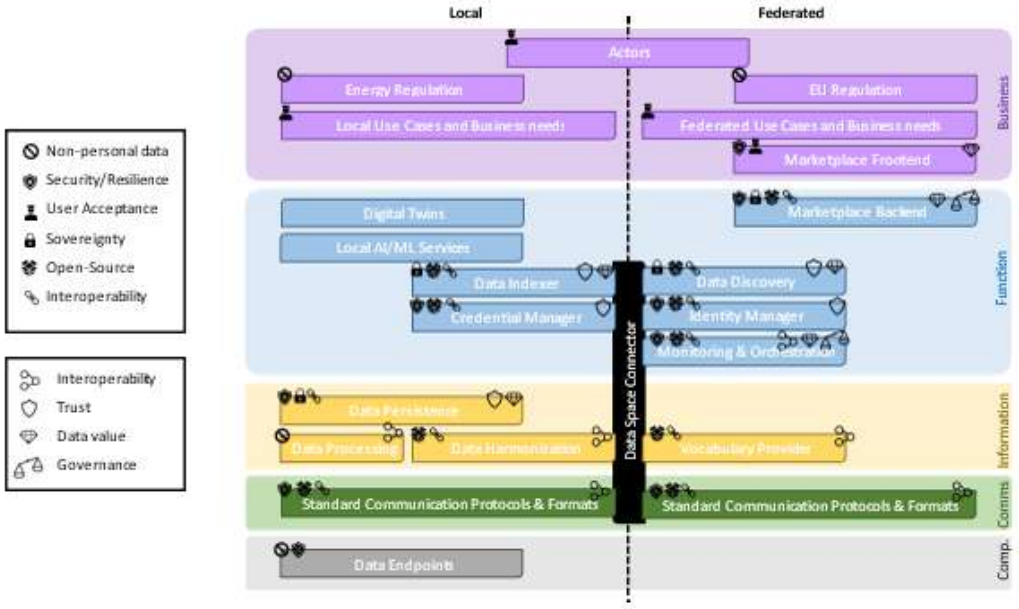

Figure 13 DERA 3.0 Layered Architecture

6.2 Involvement in the continuous refinement of DERA 3.0

The Data Management (DM) Working Group issued a survey as part of their efforts to refine and enhance the Data Exchange Reference Architecture (DERA) 3.0. This comprehensive survey was designed to collect feedback from various projects involved in data exchange, specifically those focusing on the development and implementation of data spaces. The survey covered multiple layers of DERA 3.0, including component, communication, information, function, and business layers. It aimed to gather participants' agreement with the existing components, identify any perceived missing components, assess the alignment with DERA's recommendations, and solicit suggestions for improvements or amendments.

SYNERGIES has made substantive contributions to the refinement of the DERA 3.0 architecture. Regarding the Information Layer, we emphasized the importance of specifying the level at which harmonization is applied— whether it concerns metadata, data structure, or the actual values within

datasets. This distinction is crucial for ensuring semantic interoperability across different systems and platforms within the energy data space. For the Data Processing module, we emphasized the need to distinguish between anonymization techniques and broader personal data handling strategies, proposing a more integrated approach to ensure comprehensive privacy protection.

Also, in addressing the alignment with DESAP requirements for the Data Persistence module, we identified a need for a clearer justification of how the module supports sovereignty, cybersecurity, and confidentiality/access control.

Regarding the Function layer, particularly concerning the Credential Manager (Local) and Identity Manager (Federated) modules, we highlighted the need for clarification on the roles these functionalities serve, for both data platforms/nodes and data space participants/users. Furthermore, our feedback on the Data Discovery module emphasized the necessity to establish a clear link with the Data Persistence Module. To this end, we aimed to ensure that the Data Discovery process adheres strictly to the access policies applied to the data available in the catalogue. With regards to the Monitoring and orchestration module, we pointed out that the current narrative of the monitoring functionality might be confusing and suggested that if the module primarily focuses on monitoring transactions, this should be explicitly stated. The aim is to ensure that there is clear understanding that this module's responsibility includes overseeing and recording transactions within the Data Space.

As for the Marketplace Backend module, our input emphasized the importance of including contract settlement functionalities within the clearing house component. This addition aims to ensure the marketplace not only facilitates the matching of offers and demands but also effectively manages the completion and settlement of contracts and transactions.

On the Business Layer of the Architecture, and more specifically for the Marketplace Frontend module, we suggested that the separation into two distinct modules across different layers can be avoided, proposing instead a consolidation with the Marketplace Backend module mentioned under the Function Layer.

Also, in contributing to the instantiation of DERA 3.0, SYNERGIES followed a structured approach to align its architecture with DERA's data exchange framework. This involved a thorough review of the DERA 3.0 documentation, the utilization of the provided template for the detailed renaming and breakdown of components to match SYNERGIES' architecture as well as for the functionality mapping, as depicted in the following figures.

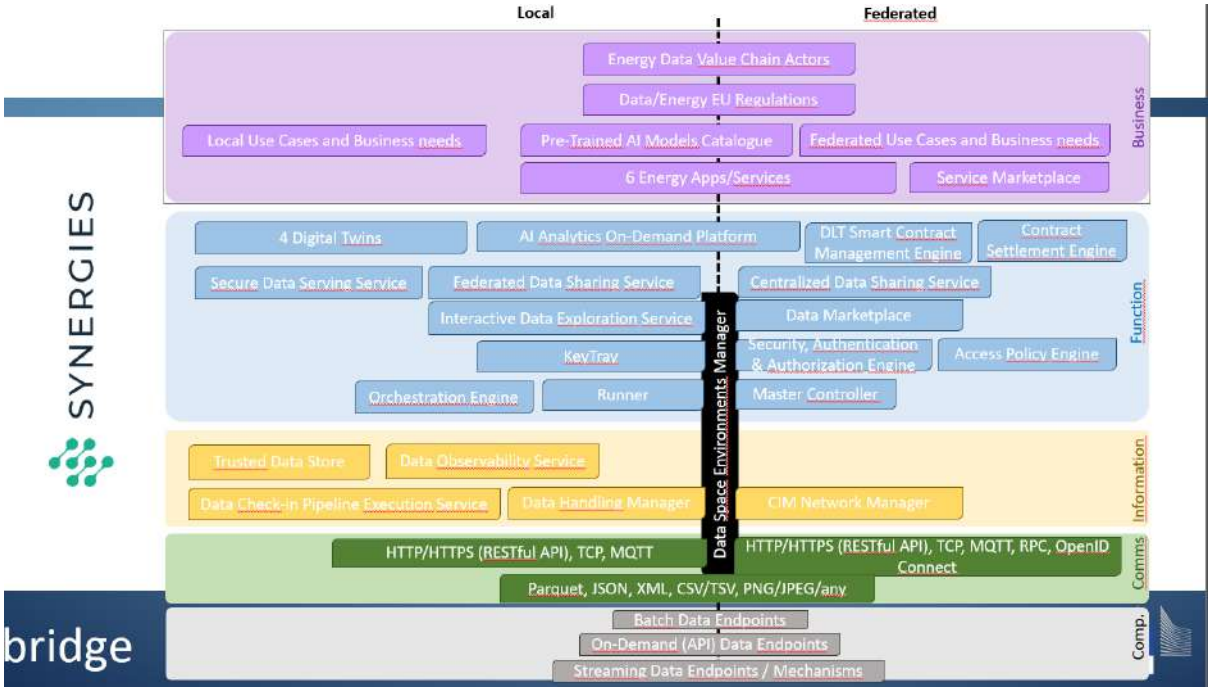

Figure 14 DERA 3.0 Component breakdown aligning to SYNERGIES architecture

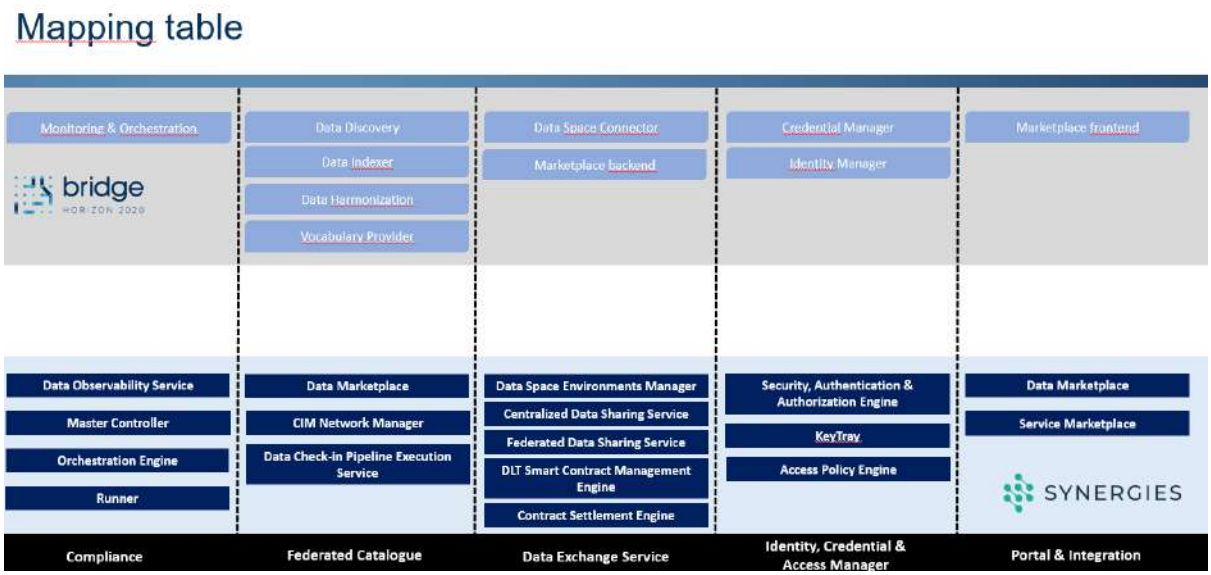

Figure 15 Functionality Mapping between DERA 3.0 and SYNERGIES

6.3 Overview of activities

The table below presents an overview of the SYNERGIES' involvement in the collaboration activities conducted in the frame of the BRIDGE Data Management Working Group and relevant contributions, up to Month 18 of the project.

Title	Date	Summary of Activities	Participation Type
BRIDGE/ Data Management WG DERA 3.0 Architecture Presentation	16/12/2022	○ Presentation of current version of the DERA architecture (DERA 2.0) and all the components involved. ○ Presentation of a preliminary approach for DERA 3.0. ○ Assignment of responsibilities to the members of the WG (focus on organizations involved in Data Space projects), for drafting a white paper for DERA 3.0	Remote participation in meeting
BRIDGE General Assembly Meeting	28-29-30/3/2023	○ Contribution to the Session "Setting up a common European data space for energy", focusing on high-level use cases and Energy Data Space building blocks	Remote participation in meeting/ Contribution
BRIDGE/ Data Management WG Kick-off Meeting	28/6/2023	○ Contribution to the specifications for the Data Exchange Reference Architecture (DERA) 3.0, enhancing data exchange in energy. ○ Engagement in enriching the Use Cases repository on the EIRIE platform.)	Contribution
BRIDGE/Data Management WG – DERA #2 meeting	27/10/2023	○ Discussion on the upcoming survey for the implementation of DERA 2.0 in projects ○ Discussion on the adoption of the Harmonized Role Model - Further elaboration on a possible role for a "Dataspace operator" and assessment of the need to introduce it ○ Update on the DERA 3.0 version and discussion on the actions for further update and refinement during 2024 ○ Identification of the need to complement DERA 3.0 with business components (services on top of the core architecture)	Remote participation in meeting
BRIDGE Data Management WG meeting – subaction 3.1	13/11/2023	○ Organize the work of sub-action 3.1 on the Reference framework (Generic Business Processes for Flexibility) ○ Alignment with SGTF implementing acts for Demand Response ○ GBPs to be introduced as reference UCs in the EIRIE repository	Remote participation in meeting
BRIDGE Data Management WG – ENLIT participation (Paris)	28/11/2023	○ Elaboration and refinement of specifications for the interoperability of smart home appliances – focus on real-time data management and semantic interoperability ○ Discussion and further refinement of DERA 3.0 reference architecture	Physical participation in meeting
BRIDGE DERA 3.0 subaction 2.5	17/1/2024	○ Contribution to the DERA3.0 Working Document regarding the Function and Business Layers of the Architecture ○ Contribution to the instantiation of DERA 3.0 in SYNERGIES	Contribution

Title	Date	Summary of Activities	Participation Type
BRIDGE Data Management WG meeting	18/1/2024	○ Progress and status review of various actions within the BRIDGE initiative. ○ Discussions on survey results, ongoing liaisons, webinars, code repositories, and the synchronization with other initiatives	Remote participation in meeting
BRIDGE action #2 meeting	15/2/2024	○ Elaboration of the annual report to be presented in the General Assembly (April 2024)	Remote participation in meeting

Table 3 SYNERGIES involvement in the BRIDGE Data Management Working Group Activities

7 Elaboration of Business Models around Energy Data Spaces

7.1 Data Valorization and new data sharing-driven business models for the Energy sector

Elaboration of novel business models in collaboration with other relevant projects, was performed in the frame of the BRIDGE Business Models Working Group activities. The BRIDGE Business Models Working Group (BM WG) has been actively engaged in a series of activities aimed at enhancing the development, quantification, and valorisation of business models within the framework of BRIDGE projects. The activities span from the review of tools and methodologies to collaborative efforts with other working groups and the planning of workshops and webinars for knowledge sharing and feedback gathering. As an active participant in the BRIDGE Business Models Working Group (BM WG), SYNERGIES played a significant role in shaping the group's activities through various meetings and working sessions. SYNERGIES was actively involved in dedicated brainstorming sessions focused on addressing the Technology Readiness Level (TRL) gap in relation to business models.

On the side of SYNERGIES, focus is given on the Data Valorisation activities within novel business models for the energy value chain. Through the business modelling activities of the project and the first results of the data sharing-driven business models that will be delivered and assessed in the frame of the project, SYNERGIES has committed to reveal the importance of valorizing data to improve cost efficiency and market introduction of new solutions. To this end, SYNERGIES has committed to effectively contribute to the establishment of a closer collaboration with the Data Management WG to showcase how data can be valorized within the use cases already defined and how new business models can emerge out of transparent data transactions (under monetized and bartering models) that can effectively create win-win situations for all involved actors.

7.2 Next Steps

In the upcoming period, SYNERGIES will provide tangible contributions to the Business Models working group stemming from the business modelling activities performed in the project. Through the alignment of the SYNERGIES use cases with the use cases defined in BRIDGE, dedicated contributions will be provided addressing (i) the implementation of targeted BRIDGE use cases with the utilization of Energy Data Spaces for data sharing and data value chain integration, and (ii) data valorization and monetization aspects effectively transforming current business practices under the principles of data sharing and allowing for the creation and assessment of new data sharing-driven business models with profound efficiency gains and financial benefits for all involved data value chain stakeholders.

7.3 Overview of activities

The table below presents an overview of the SYNERGIES' involvement in the collaboration activities conducted in the frame of the BRIDGE Business Models Working Group and relevant contributions, up to Month 18 of the project.

Title	Date	Summary of Activities	Participation Type
BRIDGE/ Business Models WG Launch of Activities	14/11/2022	○ Presentation of the scope of the activities of the Working Group ○ Discussion on activities planning	Remote participation in meeting
BRIDGE General Assembly Meeting	28-29-30/3/2023	○ Contribution to the Session "Setting up a common European data space for energy", focusing on high-level use cases and Energy Data Space building blocks	Remote participation in meeting/ Contribution

Title	Date	Summary of Activities	Participation Type
BRIDGE Business Models WG Meeting	23/5/2023	○ Discussion on the tasks and future activities ○ Brainstorming session on how to deal with the TRL gap from the BM perspective	Remote participation in meeting
BRIDGE Business Models WG meeting	27/6/2023	○ Discussion on the tasks and future activities ○ The focus of the working group primarily on Topic 2 - Design of tools to evaluate the benefit of services and solutions and Topic 3 - Design of business models to enhance data value chain observability	Remote participation in meeting
BRIDGE Business Models WG Monthly meeting	28/9/2023	○ Discussion on proposed document to collect data for knowledge hub ○ Analysis of the preliminary results	Remote participation in meeting
BRIDGE WG on BM - Regular Monthly meeting	23/10/2023	○ Chair introduction ○ Task 1, 2, 3 updates	Remote participation in meeting

Table 4 SYNERGIES involvement in the BRIDGE Business Models Working Group Activities

8 Enabling Consumer and Citizen Engagement in Energy Transition

SYNERGIES invests a lot in Consumer Engagement in energy activities and to this end, collaboration with other relevant projects for knowledge exchange and experience sharing is considered pivotal. In this frame, SYNERGIES was intensively engaged in the activities of the BRIDGE Consumer and Citizen Engagement Working Group (CCE WG) and contributed to various working sessions related to the definition of tools, strategies and methods for increasing engagement of citizens in energy activities, as well as to the specification of dedicated KPIs for objectively measuring the level of engagement.

SYNERGIES project was presented to and discussed with the BRIDGE participants.

In addition, SYNERGIES and its stakeholder engagement activities will be included in the BRIDGE annual report as the best practice example.

8.1 Elaboration of Methods and Tools for Enhanced Consumer Engagement in the Energy Transition

As part of the collaboration activities under this Working Group, SYNERGIES, in collaboration with other involved members, explored various projects focused on enhancing consumer engagement in flexibility markets and renewable energy. Based on the achievements of these projects (user-centric approaches and smart tools for engagement), SYNERGIES actively participated in the assessment of the practical application of relevant approaches and the definition of methods for bridging the (abstract) theories and frameworks with the very practical work of measuring engagement on the ground. Finally, as part of the activities of the Working Group, a Handbook on Strategies of Engagement is planned to be released and SYNERGIES has committed to contribute with the methods, experience and lessons learned during the implementation of the Living Labs activities of the project.

8.2 Next steps for the upcoming period

In the upcoming period, SYNERGIES will intensify its involvement in the Working Group activities towards finalizing the contributions of the project to the Handbook on Strategies of Engagement based on the practical experience gained through the implementation of the Living Labs and the respective consumer and stakeholder engagement activities in the SYNERGIES demo sites. Moreover, an internal assessment of useful tools for sustained engagement that could be utilized in the SYNERGIES context will be performed, while exploring the possibility to step on existing methodologies for assessing engagement in order to carry out the relevant activities of the project.

8.3 Overview of activities

The table below presents an overview of the SYNERGIES' involvement in the collaboration activities conducted in the frame of the BRIDGE Consumer and Citizen Engagement Working Group and relevant contributions, up to Month 18 of the project.

Title	Date	Summary of Activities	Participation Type
BRIDGE General Assembly Meeting	28-29-30/3/2023	○ Contribution to the Session "Setting up a common European data space for energy", focusing on high-level use cases and Energy Data Space building blocks – provision of input to the common presentation provided by the int:net project	Remote participation in meeting

Title	Date	Summary of Activities	Participation Type
BRIDGE/Consumer Engagement Indicators of Engagement Kick-off Meeting	14/6/2023	○ Kick off and planning of activities	Remote participation in meeting
BRIDGE/Consumer Engagement Smart Tools Kick-off Meeting	21/6/2023	○ Kick off and planning of activities ○ Presentation of survey results on usage of smart tools/methodologies within the projects	Remote
BRIDGE/Consumer Engagement Strategies of Engagement Kick-off Meeting	28/6/2023	○ Kick off and planning of activities ○ Projects presentation	Remote participation in meeting
BRIDGE/Consumer Engagement - Smart Tools Planning meeting	18/7/2023	○ Definition of objectives and tasks	Remote participation in meeting
BRIDGE/Consumer Engagement - Indicators of Engagement Planning meeting	8/8/2023	○ “Bridge” between (abstract) theories and frameworks on how engagement works and the very practical work of measuring engagement on the ground	Remote participation in meeting
BRIDGE/Consumer Engagement - Indicators of Engagement	6/9/2023	○ Presentations of projects, ○ Preparation of future work	Remote participation in meeting
BRIDGE/Consumer Engagement - Strategies of Engagement Quarterly call	8/9/2023	○ Webinar/workshop preparation ○ Handbook on Strategies of Engagement preparation	Remote participation in meeting
BRIDGE CCE WG All members meeting 3 -	12/9/2023	○ Update on projects and key issues	Remote
BRIDGE/Indicators of Engagement – Theories of engagement	6/10/2023	○ Discussion on theories of engagement	Remote
BRIDGE/Consumer Engagement	13/10/2023	○ Distribution of work on presentation of cases ○ Work on handbook ○ Workshop on "Failures in Engagement"	Remote
BRIDGE/Consumer Engagement – General ad hoc meeting	17/10/2023	○ Information by different Working Groups Leaders on the forthcoming activities in their area of work	Remote participation in meeting
BRIDGE Strategies of Engagement Regular Monthly Meeting	10/11/2023	○ Progress General updates	Remote participation in meeting
BRIDGE Strategies of Engagement "Failing engagement - Reasons and Mitigation Activities"	21/11/2023	○ Discussion on typical moments of "engagement failure" in R&I projects	Remote participation in meeting

Title	Date	Summary of Activities	Participation Type
BRIDGE Theories of Engagement BRIDGE SG Theories of Engagement	27/11/2023	○ Discussion on how to bring theories down to the practical benefits on the ground of projects	Remote participation in meeting
BRIDGE Strategies of Engagement SoE general meeting	7/12/2023	○ Project Presentation	Remote participation in meeting
BRIDGE SG Indicators of Engagement WC Meeting	17/1/2024	○ Focus of activities on the upcoming annual report	Remote participation in meeting
BRIDGE Smart Tools SG Consumers and Citizen Engagement workshop	29/1/2024	○ Workshop on engagement tools and methods	Remote participation in meeting
BRIDGE SG Indicators of Engagement Regular monthly meeting	5/2/2024	○ Discussion on the Report Status	Remote participation in meeting
BRIDGE - Strategies of Engagement General meeting	9/2/2024	○ General Updates ○ Project Presentation	Remote participation in meeting
BRIDGE- CCE WG	19/02/2024	○ Updates from the subgroups ○ Collection of members' feedback for next steps	Remote participation in meeting

Table 5 SYNERGIES involvement in the BRIDGE Consumer and Citizen Engagement Working Group Activities

9 Interoperability in the Energy Sector

The International Data Spaces Association (IDSA) has launched the Data Spaces Support Centre initiative, funded by the European Commission's Digital Europe Program with the aim to streamline the coordination of sectoral data spaces across Europe, fostering an ecosystem where data can be used and shared seamlessly across different sectors. The Energy Interoperability Task Force, spearheaded by the Data Space Support Center (DSSC), has marked a significant stride toward fostering interoperability within the energy sector. Among the various projects contributing to this initiative, SYNERGIES has stood out through its active engagement and substantial contributions.

9.1 Establishing the Framework for Energy Interoperability

The journey of the task force in defining an interoperability framework for the energy domain commenced with brainstorming sessions that fostered a dynamic exchange of insights and innovative approaches towards energy interoperability. These initial discussions, set the foundation for collaborative efforts in tackling the complexities of interoperability within the energy sector.

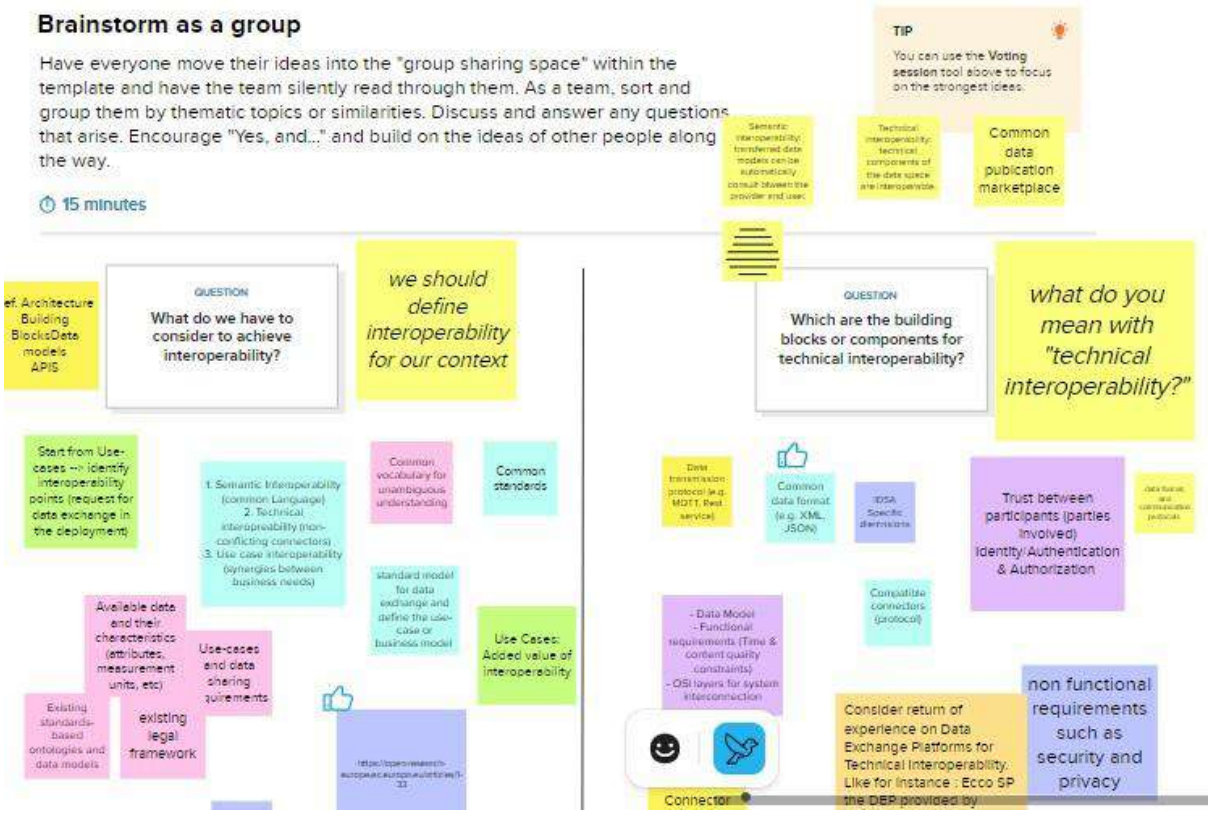

Figure 16 Brainstorming session insights

Following this foundational phase, the task force engaged in technical and semantic interoperability workshops aimed at preparing a white paper. These workshops brought to light the critical discussions around marketplace models and the imperative of a unified approach towards interoperability across various implementations of federated services. In these in-depth sessions, SYNERGIES participated in dedicated working sessions and engaged with other members of the Energy Interoperability Task Force. This collaboration focused on the practical implementation of the interoperability framework in identified use cases, thereby highlighting the synergy between brainstorming insights and the collective efforts towards advancing interoperability in the energy sector.

With regards to the white paper preparation, SYNERGIES provided targeted contributions concentrating on semantic interoperability challenges and regulatory issues associated with CEEDS implementation. Moreover, additional contributions were provided towards assessing potential use

cases, illustrating how semantic interoperability could spur innovation and enhance efficiency within the energy sector. The initial version of the White Paper was unveiled on October 19, 2023, with Task Force members now focusing on refining and advancing the document's second iteration.

9.2 DSSC Data Spaces Survey

The primary purpose of the survey was to gather comprehensive insights from various data space initiatives within the DSSC's Community of Practice and beyond. This endeavour aimed to understand the diverse nature, setup, and current stages of these initiatives to facilitate the monitoring and evaluation activities carried out by the Data Spaces Support Centre (DSSC).

Structured around seven themes, the survey invited respondents to offer detailed information about their data space initiatives, including general information, business, legal and governance viewpoints, operational, functional, and technical perspectives, among others. This self-description process allowed for a rich sense of the preparation, implementation, and unique challenges faced by each initiative, contributing valuable knowledge to guide the development of further support services by the DSSC.

SYNERGIES contributed to the Data Spaces Survey providing essential information about the SYNERGIES concept and approach, while further deep diving to the analysis and assessment of the degree of alignment with the Data Space Building Blocks defined by DSSC.

9.3 DSSC Blueprint

The DSSC Blueprint outlines efforts to foster interoperability within the energy sector's data spaces, highlighting the critical role of digitalization for enhanced real-time operations and the importance of standards for device interoperability. It examines both technical and semantic interoperability, emphasizing the need for compatible data connectors and the harmonization of data models to facilitate seamless integration across different systems.

SYNERGIES engaged during the DSSC-Blueprint v0.5 consultation phase, providing feedback based on the SYNERGIES viewpoint on the core building blocks that should be addressed by the blueprint.

Figure 17 New Energy Interoperability Framework

9.4 Overview of activities

The table below presents an overview of the SYNERGIES' involvement in the collaboration activities conducted in the frame of the Data Spaces Support Centre (DSSC) and the Energy Interoperability Task Force and relevant contributions, up to Month 18 of the project.

Title	Date	Summary of Activities	Participation Type
IDSA Energy interoperability task force	7/3/2023	○ Interoperability framework for the energy domain definition ○ Implementation in specific use cases and relevant documentation provision for the standardisation committees	Remote participation in meeting

Title	Date	Summary of Activities	Participation Type
		○ Aiding projects in their intra and inter data spaces interoperability tasks	
Energy interoperability task force Technical & Semantic interoperability workshops	12/5/2023	○ Brainstorming for white paper preparation	Remote participation in meeting
DSSC Energy Interoperability Task Force Technical Interoperability Workshop	15/5/2023	○ Decision-making regarding the marketplace structure, deliberating between a single marketplace or a federated marketplace approach ○ Focus on the challenge of ensuring interoperability among different implementations of Federation Services	Remote participation in meeting
Energy interoperability task force Energy TF - Semantic interop. follow-up	23/5/2023	○ Further elaboration on the content of the white paper ○ Assignment of roles and responsibilities ○ SYNERGIES commitment in providing input on Semantic Interoperability Challenges	Remote participation in meeting
Energy interoperability task force Semantic Interoperability - White paper Contribution provision	15/6/2023	○ Analysis of the challenges that Energy systems and networks face in semantic interoperability, ○ Elaboration of a more comprehensive and advanced harmonization approach for seamless integration in a smart energy system.	Contribution
Energy interoperability task force Use Cases Contribution	26/6/2023	○ Preparation of additional input (within June) addressing core building blocks and use cases of SYNERGIES	Contribution
Energy interoperability task force Use Cases Meeting	30/6/2023	○ Use cases content definition for the White Paper	Remote participation in meeting
Energy interoperability Task Force paper status meeting	18/7/2023	○ Discussion on the drafting status of the White Paper meeting	Remote participation in meeting
Energy interoperability Task Force Touchpoint meeting	29/8/2023	○ Meeting for the white paper preparation	Remote participation in meeting
DSSC Data Spaces Survey	6/9/2023	○ Contribution on the survey assessing the alignment of the SYNERGIES Energy Data Space with the core Data Space Building Blocks of DSSC Blueprint Version 0.5	Contribution
Energy interoperability Task Force Touchpoint meeting	15/9/2023	○ Meeting for the white paper preparation ○ Provision of revisions on Semantic Interoperability	Remote participation in meeting
Energy interoperability Task Force White Paper 1st version Publication	19/10/2023	○ Contribution to the White Paper “Interoperability Framework in Energy Data Spaces”, focusing on semantic interoperability challenges and approaches	Contribution

Title	Date	Summary of Activities	Participation Type
Energy interoperability Task Force White Paper 2nd Iteration	30/11/2023	○ Elaboration of topics to be addressed in the 2nd version of the White Paper	Remote participation in meeting
Energy interoperability Task Force White Paper 2nd Iteration Follow-up meeting	16/1/2024	○ Contribution with cross-sector integration use case	Contribution

Table 6 SYNERGIES involvement in the DSSC-Energy Interoperability Task Force Activities

10 Collaboration with ETIP SNET

SYNERGIES actively participated in shaping policy recommendations to support the deployment of Common European Energy Data Spaces (CEEDS), collaborating with the European Technology and Innovation Platform for Smart Networks for Energy Transition (ETIP-SNET). This involvement aimed at advancing the digital energy transition across the EU through targeted policy recommendations.

10.1 Participation in ETIP SNET events

In 2023, SYNERGIES was actively involved in crucial events that aimed to define the trajectory of energy data spaces within Europe. The engagement began with an introductory meeting hosted by ETIP SNET Working Group 4, where SYNERGIES contributed to crafting an in-depth report on the digitalization of the electricity system and customer participation. The initiative progressed with a specialized workshop focused on addressing the main challenges and proposing policy and regulatory solutions for the implementation of energy data spaces across Europe. Furthermore, SYNERGIES took part in the ETIP-SNET & BRIDGE Joint Workshop in Brussels, June 2023. This event was a significant milestone where preliminary outcomes and critical recommendations were shared, offering early insights derived from the collaborative efforts in drafting the Policy Paper on Energy Data Spaces.

10.2 SYNERGIES contributions to the Policy Paper of ETIP SNET

The policy paper delves into the development and implications of data spaces within the European energy sector, emphasizing the crucial role they play in integrating renewable energy sources and advancing towards EU's energy transition goals. It outlines the necessity of establishing a secure and interoperable framework for data sharing across the continent, highlighting the varying data management strategies among member states and the potential of decentralized, centralized, and hybrid models. It also advocates for policies that promote seamless integration, data protection, and the democratization of the energy system, ensuring customers and grid operators benefit from enhanced access to data and flexibility in the evolving energy landscape.

SYNERGIES contributed to drafting the ETIP SNET policy paper, published on January 2nd, 2024, focusing on technical, regulatory, and organizational challenges related to energy data spaces in Europe, and suggesting appropriate policy instruments for these challenges.

Contributions to the policy paper emphasized the need for comprehensive frameworks for sharing energy data, advocating for architectures that ensure trust and prioritize customer benefits. The policy recommendations highlighted the importance of simplifying the energy system's complexity to enhance customer participation and leveraging digitalization to streamline access and participation processes. SYNERGIES emphasized the role of data-driven and AI-enabled innovations in mobilizing consumer engagement through intelligent, automated services that can interpret consumer preferences into actionable insights for energy market participation.

Furthermore, SYNERGIES highlighted the necessity for robust, interoperable data collection and sharing mechanisms to support consumer engagement in energy activities and market transactions. The aim is to facilitate a seamless, automated journey for consumers to engage in energy markets, maximizing the benefits of participation through data intelligence and optimization solutions.

10.3 Overview of activities

The table below presents an overview of the SYNERGIES' involvement in the collaboration activities conducted in the frame of the ETIP SNET and relevant contributions, up to Month 18 of the project.

Title	Date	Summary of Activities	Participation Type
ETIP SNET Working Group 4 "Digitalisation of the electricity	20/4/2023	○ Contributions towards the preparation of a report on energy data spaces	Contribution

Title	Date	Summary of Activities	Participation Type
system and customer participation			
ETIP SNET policy paper on data spaces - Projects workshop	17/5/2023	○ Address the key challenges involved in implementing energy data spaces in Europe, ○ Provide policy and regulation recommendations to overcome these challenges and promote the effective establishment and operation of energy data spaces.	Remote participation in meeting
ETIP SNET Policy Paper contribution	9/6/2023	○ Elaboration on technical challenges and needs for energy data spaces ○ Elaboration on organizational needs and trustworthiness in data sharing	Contribution
ETIP SNET & BRIDGE networking event - Key results and steps forward	20/6/2023	○ Presentation of current achievements of the various WGs ○ Initial hints on the Policy Paper on Energy Data Spaces	Physical participation in meeting
ETIP SNET Policy Paper Publication	2/1/2024	○ Publication of the ETIP SNET WG4 Policy Paper	Contribution

Table 7 SYNERGIES involvement in ETIP SNET activities

11 Leveraging Energy Data Spaces for Flexibility Markets and Transactions

The collaborative activities with EnTEC were focused on delving into the role of energy data spaces within energy flexibility initiatives and crafting policy recommendations that align with critical factors such as energy market regulation, standardization, data access, and trust considerations.

Under EnTEC, two purpose-driven workshops were organized to dive into the nexus between energy flexibility initiatives and the pivotal role of data spaces. The initial workshop embarked on a comprehensive analysis of various initiatives showcasing how data spaces serve as central pillars in driving energy flexibility. Through engaging breakout sessions, participants critically explored the dynamics between data spaces and energy management, including the facilitation of renewable energy integration. These deliberative sessions shed light on the innovative approaches and models data spaces offer, marking a step forward in redefining the energy sector's future.

Progressing from the groundwork laid in the initial meeting, the subsequent workshop ventured into an in-depth examination of the obstacles and challenges that emerge when deploying data spaces within the realm of energy flexibility.

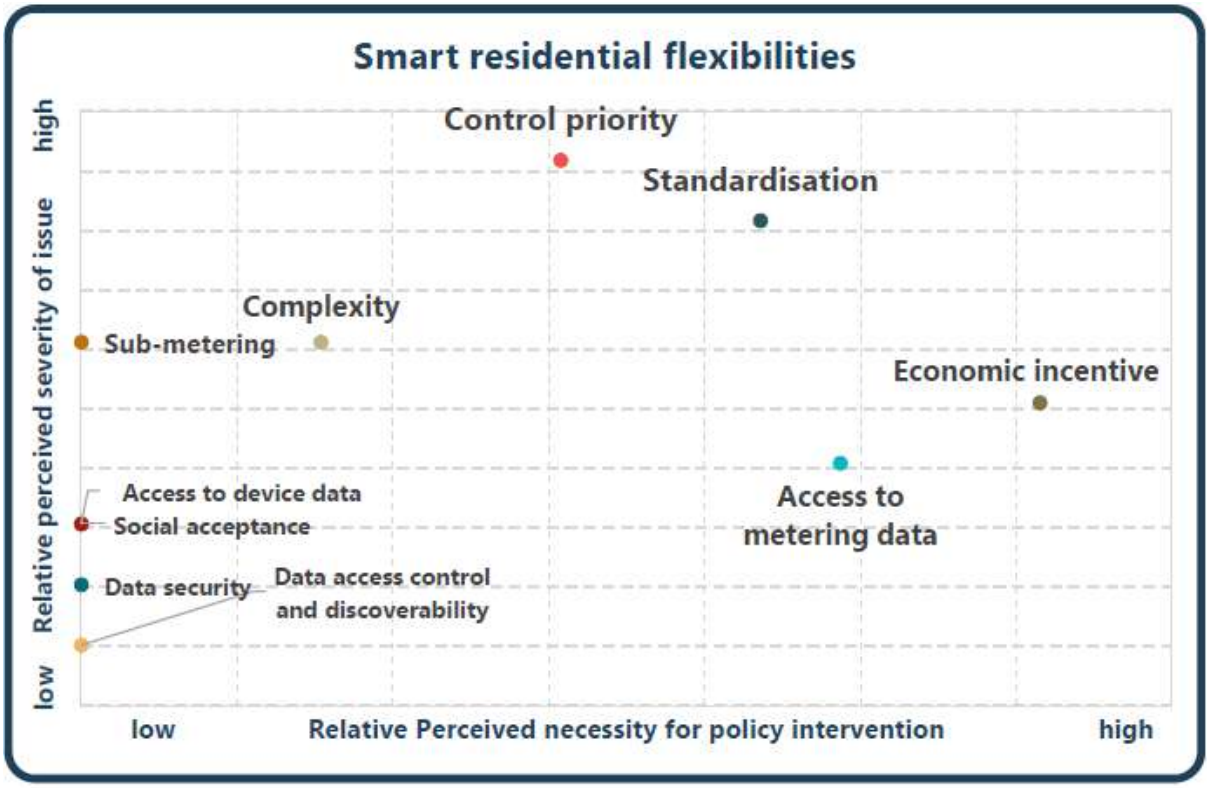

Figure 18 Pain points identified during workshop

This session was marked by a collaborative effort to craft pragmatic policy recommendations tailored to navigate the complexities of energy market regulations, standardization processes, data accessibility, and fostering trust. The collective endeavour aimed not only at pinpointing solutions to existing challenges but also at charting a course for maximizing the utility of data spaces in enhancing energy flexibility, setting the stage for a unified and effective energy ecosystem. The results of this collaboration together with the relevant recommendations were included and populated the content of the EnTEC report (October 2023) [26] named “Common European Energy Data Space”, addressing the role of Energy Data Spaces in realizing flexibility use cases and providing the relevant policy recommendations.

11.1 Overview of Activities

The table below presents an overview of the SYNERGIES' involvement in the collaboration activities conducted in the frame of the Energy Transition Expertise Centre (EnTEC) and relevant contributions, up to Month 18 of the project.

Title	Date	Summary of Activities	Participation Type
EnTEC Energy Flexibility and Data Spaces Workshop	16/5/2023	○ Initiatives on energy flexibility analysis, in which data spaces are playing a central role ○ Breakout sessions with focused discussions	Remote participation in meeting
EnTEC Workshop on Energy Data Spaces	20/6/2023	○ Review of pain points from flexibility use cases ○ Presentation of implications on data space building block requirements ○ Presentation of draft policy recommendations ○ Workshop with discussion and tuning of policy recommendations	Physical participation in meeting
EnTEC Report "Common European Energy Data Space" Publication	13/10/2023	○ Energy Data Spaces in realizing flexibility use cases ○ Providing the relevant policy recommendations.	Contribution

Table 8 SYNERGIES involvement in EnTEC activities

12 Conclusions

SYNERGIES project has made significant progress in advancing the development and implementation of a Common European Energy Data Space (CEEDS) through its multifaceted approach to interoperability, business model development, stakeholder engagement, and policy advocacy.

By leveraging strategic partnerships with sister projects, participating in collaborative initiatives, and actively contributing to the refinement of key frameworks such as DERA 3.0, SYNERGIES has positioned itself at the forefront of shaping the future of energy data management in Europe.

Through active participation in initiatives such as the BRIDGE Business Models Working Group and the Consumer and Citizen Engagement Working Group, SYNERGIES demonstrates a holistic approach to the energy transition. By focusing on technology readiness, the development of robust business models, and strategies for effective stakeholder engagement, the project aims to create a user-centric and inclusive energy ecosystem.

Collaboration with the Energy Interoperability Task Force, ETIP-SNET, and EnTEC highlights SYNERGIES' role in shaping interoperability frameworks, policy recommendations, and exploring the potential of energy data spaces in facilitating energy flexibility and integration. These partnerships are essential for advancing the digital energy transition across the EU, promoting innovation, and enhancing the efficiency and sustainability of the energy sector.

Moving forward, SYNERGIES remains committed to furthering its collaborative efforts, driving innovation, and facilitating the transition towards a more flexible, digitalized, and sustainable European energy system.

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