www.eclipse-digital.eu

28 August 2025

D4.1 – ECLIPSE CERF for Energy Saving applications_V1

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them. DIGITAL EUROPE Grant agreement N° 101158494.

Deliverable details

Title	WP	Version
D4.1 – ECLIPSE CERF for Energy Saving applications_V1	4	1.0

Contractual delivery date	Actual delivery date	Delivery type*	Dissemination**
M12 (August 2025)	M12 (August 2025)	R	PU

* Delivery type: R: Document, report; DEM: Demonstrator, pilot, prototype; DEC: Websites, patent fillings, videos, etc; DMP: Data management plan.
** Dissemination Level: PU - Public; SEN – Sensitive, limited under the conditions of the Grant Agreement.

Author(s)	Organization
Diego García-Casarrubios	ETRA

Version	Date	Person	Action	Status***
0.1	17/01/2025	Diego García-Casarrubios (ETRA)	Document creation, Table of Contents	Draft
0.2	18/06/2025	Diego García-Casarrubios (ETRA), Lola Alacreu (ETRA), Alejandro Vicent (ETRA), Dune Sebilleau (TRIALOG), Diana Jiménez (TRIALOG), Tareq Chy (TRIALOG), Shievam Kashyap (FHOOE), Katerina Drivakou (UBITECH), Stamatis Diakakis (UBITECH), Christos Pavlatos (UBITECH)	Table of Contents revision, main contents included	Draft
0.3	04/07/2025	Witold Krasny (D4G), Aurore Fourcroy (VOLTALIS), Eleonore Glendinning (VOLTALIS), Uršula Krisper (EL), Kristina Pandžić (HOPS), Anna Smičková (CEZd), Biernot Krzysztof (TAURON), Izabel Georgieva (ESO), Vassilis Boglou (HEDNO), George Falekas (HEDNO), Raúl Peña (i-DE), Javier Fernández (i-DE), Mihai Sanduleac (NUSTPB), Andreea Iantoc (NUSTPB), Ana Carolina Monteiro (E-REDES), Miguel Louro (E-REDES), Sonam Parashar (R&D NESTER), Kamalanathan Ganesan (R&D NESTER)	Pilots' contributions and revision	Draft
0.4	15/07/2025	Diego García-Casarrubios (ETRA)	Consolidation, revision, and completion	Draft
0.5	25/07/2025	Ana Carolina Monteiro (E-REDES), Sita Carvalho (E-REDES), Anna Smičková (CEZd), Jan Kůla (CEZd), Aurore Fourcroy (VOLTALIS), Kristina Pandžić (HOPS), Lia Fotopoulou (METLEN), Lola Alacreu (ETRA)	Partners review	Draft

0.6	01/08/2025	Diego García-Casarrubios (ETRA), Christos Pavlatos (UBITECH), Ana Carolina Monteiro (E-REDES), Uršula Krisper (EL), Anna Smičková (CEZd)	Final modifications and contributions based on partners revision	Draft
1.0	08/08/2025	Diego García-Casarrubios (ETRA)	Final version of the document	Final

***Status: Draft, Final, Approved, Submitted (to European Commission).

KEYWORDS

CERF, Common European Reference Model, Architecture, Implementation, Semantic Interoperability, Energy Apps, APIs, Generic Adapters, Governance, Data Spaces, Stakeholders

EXECUTIVE SUMMARY

The document presents the current status of the implementation of the ECLIPSE Common European Reference Model (CERF), together with a summary of its foundations and main characteristics, as part of its open-source development plan.

A step-by-step roadmap for the creation of the CERF has been defined with detailed information from its initial definition and objectives up to its maintenance, replication, and beyond. Each step in the roadmap is linked to the corresponding Task or Work Package where it will be fulfilled.

Three software foundations from other projects and open-source organisations have been appointed as potential interoperable connectors that will ease the integration of existing components into the CERF. These connectors are the Generic Adapter (GA) from InterConnect project [1], the EDDIE connector from OneNet [2]/EDDIE [3], and the Eclipse Semantic Modelling Framework (ESMF) from the Eclipse Foundation [4].

In order to define the governance scheme of the CERF, the analysis of this aspect is performed for two of the main European Data Spaces initiatives (IDSA [5], Gaia-X [6]) and two Horizon Europe projects

(Enershare [7], SYNERGIES [8]). Both their structure and their incentive mechanisms are studied and, in the case of the two projects, the analysis tries to align them with the IDSA governance framework in order to extract a standardised schema that can be applied to the CERF.

All 13 demo pilots have been studied in order to define a tailored stakeholder's engagement plan for each of them. They include the list of identified stakeholders, engagement activities, risks and mitigations in order to achieve their active involvement in the project with regards to the CERF.

The current status of the architecture of the CERF is briefly presented, where the main components and interfaces are described. From these interfaces, a subset of them is selected and generic APIs defined for the facilitation of the exchange of data through them. Moreover, the first prototype of the ECLIPSE user application is presented, detailing its functionalities and user interface.

Finally, the first version of the pilot implementation is presented for each demo site. In each case, an overview of their development plan is described, followed by the identified data spaces and data sources, energy services, and end user applications to be either fully implemented or adapted and integrated into the CERF.

COPYRIGHT STATEMENT

INDEX

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1. PURPOSE OF THE DOCUMENT

This deliverable describes the development plan and implementation of the ECLIPSE Common European Reference Model (CERF) in the 13 pilots included in the project.

The development plan includes the identification of software foundations that enhance the data exchange and semantic interoperability among the elements of the ECLIPSE CERF architecture, as well as the analysis of stakeholders in each pilot and a proposed engagement plan to foster their participation.

Details of the first implementation of the ECLIPSE CERF in the 13 pilots (currently under development by the submission of this deliverable) are provided, focusing on the particular elements (data sources, energy services, user applications) that will be involved in each of them. The document describes the horizontal components as well, such as API interfaces, the ECLIPSE user application, and other services shared by several demo sites, which are used as building blocks that facilitate the implementation of the ECLIPSE CERF both in the project's demo sites and in future instances beyond it.

1.2. SCOPE OF THE DOCUMENT

This deliverable presents the outcomes of WP4 "Design and development of CERF and APIs" during the first year of the project. Tasks 4.1 "Open-source CERF development plan" to 4.3 "User interface apps development and support to App developers" were the central target of the effort, as Task 4.4 "Verification, validation and maintenance of the CERF" started on M10 and will be only active for two months by the submission of this document—its outcomes will be provided as part of D4.2 (due M24).

The implementation of the ECLIPSE CERF, as described in WP4, is built upon the work of WP2 "CERF use cases, requirements and services" and WP3 "Architecture of a scalable and interoperable European open-source CERF and data sets" and will be continued in parallel with WP5 "Preparation, coordination and monitoring of deployment and demonstration activities". The outcomes from T4.1 are mainly presented in Section 2 of this document, and are based on the definition of the architecture, interfaces, and standards done as part of WP3. While the complete details will be presented in D3.1 (due M15), the current stage of these results has been used to describe the ECLIPSE CERF development plan.

In WP2, the use cases and requirements to be implemented have been defined and will be described in D2.2, to be submitted at the same time as this document. The analysis of this information has been the basis for the identification of architectural elements in the pilots as described in Section 3.4, namely the data spaces/data sources and energy services (outcomes of T4.2 "Development of the CERF for consumer applications based on Machine learning tools and AI") and the end user applications (T4.3). The definition of APIs for a subset of CERF interfaces and the design of a generic ECLIPSE user application to be integrated in different pilots are also outcomes of T4.3 and complete the content of Section 3.

1.3. STRUCTURE OF THE DOCUMENT

The document is structured as follows:

- Section 2 provides the details of an open-source development of the ECLIPSE CERF, including a roadmap for its creation (mapped to the effort in the project) in Section 2.1, the identified software foundations for its implementation in Section 2.2, and the proposed engagement plan for the stakeholders in each pilot of the project in Section 2.3.
- Section 3 describes different aspects of the current status of the implementation of the ECLIPSE CERF as part of the project. Section 3.2 briefly presents its architecture (to be explained in detail in D3.2) and proposes 3 APIs for some of its interfaces. Section 3.3 describes the design and first prototype of the ECLIPSE user application, which will be the main end user tool in some demo pilots. Finally, the implementation of the ECLIPSE CERF in the 13 pilots is described, including a general overview and the specific elements that are currently under development or integration.
- Section 4 provides the conclusions of the documents and the next steps for WP4.

2. ECLIPSE CERF OPEN-SOURCE DEVELOPMENT PLAN

2.1. ROADMAP FOR THE CREATION OF THE CERF

The creation of a Common European Reference Framework (CERF) aims at providing a set of rules and standards that help homogenizing the development of energy consumers' applications across the EU and enhancing their interoperability with third-party systems. The implementation of the CERF as part of ECLIPSE project involves the coordinated actions of several European actors and stakeholders and requires planning across multiple stages or phases that encompass from initial analyses to its final adoption within and beyond the project.

This section presents a step-by-step roadmap for the creation of the CERF and how it is being tackled within the ECLIPSE project. The identified stages, their objectives and/or outcomes, and their relationship with the structured work of the project are described below:

1. **Definition of the scope and objectives:** First of all, it is essential to define the goals of the ECLIPSE CERF in order to have a clear direction to aim the work at. The functionalities of the CERF, the actors it targets and their necessities, the technical and non-technical restrictions, and the expected outcomes need to be fully and formally defined before any implementation starts. In ECLIPSE, these analyses have been performed in the form of use cases and requirements as part of T2.2 "Co-creation of project use-cases and

energy services in collaboration with all the relevant stakeholders" and T2.3 "Definition and consolidation of CERF requirements respectively".

2. **Research and analysis of existing solutions:** The implementation of the ECLIPSE CERF cannot be built from scratch, as it aims at incorporating end user applications and systems that already exist in the real world. Moreover, it can benefit from existing technologies and services whose functionalities have long been proven due to their extended use and active communities. Additionally, the analysis of the state of the art in specific aspects related to the CERF provide a wide vision of the general tendencies while highlighting the missing pieces it can replace. In ECLIPSE, such analysis has been performed among end user applications in T2.1 "Analysis of the good practices from existing applications and services already available in the market and of the current legal framework", while the relevant datasets available in the pilot sites are being compiled as part of T3.1 "Specifications of suitable data sets and digital environment".
3. **Definition of the architecture:** The main part of the design of the ECLIPSE CERF is the formal definition of its architecture based on the analysis of the existing elements in the pilots and their interactions. The description of standard interfaces, communication protocols, data sets, and functions to be implemented by each component in the architecture is the preliminary step for the implementation of the CERF. The generic architecture of the Framework and its details are mainly defined in

T3.2 “Definition of the architecture of a scalable and interoperable European open-source CERF” and T3.3 “Definition of standard interfaces and protocols of the CERF”.

4. **Development of the components:** After the identification of the components that define the architecture of the CERF, it is necessary to define the scope of their implementation and integration in the environment they will be tested. In the case of ECLIPSE, the specific data spaces/data sources, energy services, and end user applications in each pilot and their development status have been identified and analysed, in order to assess the scope of the implementation for each of them. The selected generic adapters and other existing solutions that will be used across pilots to ease the development process are described as well. These are the main purposes of the present document and are based on the work performed in T4.1 “Open-source CERF development plan”, T4.2 “Development of the CERF for consumer applications based on Machine learning tools and AI”, and T4.3 “User interface apps development and support to app developers”. The outcomes from WP3 are the basis for this implementation, including the considerations from T3.4 “Data protection capabilities and methods regarding security and privacy threats”.
5. **Verification and validation of the components:** Before their integration in the real world, the CERF components previously developed and adapted need to be verified and validated in a controlled environment, in order to prevent errors that may jeopardize the stability of the system and compromise relevant

data. The definition of lab testing procedures for the components and APIs will be carried out as part of T4.4 "Verification, validation and maintenance of the CERF" and reported in D4.2 "ECLIPSE CERF for Energy Saving applications_V2".

6. **Deployment, adaption, and validation in pilots:** Once developed and validated in controlled conditions, the CERF components need to be deployed in the corresponding demo sites, assessing their compatibility with the existing systems and adapting the necessary setting for their complete integration. These components will then be validated in a real environment while demonstrating the previously defined use cases. In those situations where real conditions (data, assets, actors, etc.) are not available, simulations will be required to complete the corresponding demonstrations. In ECLIPSE, these efforts will be performed as part of WP5, mainly in T5.1 "Integration, deployment and adaptation activities", T5.3 "Demonstration activities by real pilots", and T5.4 "Simulations in virtual pilots".
7. **Evaluation of user satisfaction and impact:** The evaluation of the social, economic, and environmental impact of the solutions implemented as part of the ECLIPSE CERF, as well as user satisfaction, will be assessed during and after the demonstration of the project. These activities will rely on the evaluation of the KPIs defined during the planification phase and on surveys among the actors involved. T6.2 "User satisfaction assessment and social impact" and T6.3 "Innovative business models and economic and

environmental impact of CERF" will provide the expected outcomes in ECLIPSE.

8. **Maintenance and replication beyond the project:** The goal is for the CERF to be implemented beyond the ECLIPSE project. In order to achieve this, a set of guidelines for the maintenance of the CERF and its components, as well as recommendations for replication and legislation will be provided, based on the experiences gathered during the demonstration. These documents will be generated as part of T4.4 "Verification, validation and maintenance of the CERF", T6.1 "Recommendations to policymakers to facilitate the adoption of ECLIPSE results", and T6.4 "Replication and expansion strategies".
9. **Engagement and dissemination:** In order to foster the participation of stakeholders during the demonstration phase, as well as the diffusion of the benefits of the ECLIPSE CERF, awareness campaigns and dissemination activities need to be performed by the consortium. In the case of the pilots, a specific Stakeholder's engagement plan for each of them is provided in Section 2.4, which will be further monitored as part of T5.2 "Awareness and engagement activities to motivate stakeholders' active involvement". Moreover, the different information-spreading methods used during the whole lifecycle of the ECLIPSE project will be included in the reports associated to WP7 "Dissemination, communication and exploitation activities".

This high-level roadmap will be instantiated for each of the pilots later in the document, in the "Pilot overview" subsection of each demo site described in Section 3.4 Pilot implementation of ECLIPSE CERF.

2.2. SOFTWARE FOUNDATIONS

This section presents the results of the analysis of existing technologies and solutions that can facilitate the implementation of the CERF both as part of the ECLIPSE project and beyond. Although this analysis was prepared mainly under the scope of T3.3 "Definition of standard interfaces and protocols of the CERF", it is presented due to its strong relation to the development of the CERF and because the first results of WP3 will be presented at a later date.

The aim of the task is to identify, compare, and potentially adopt existing interoperable "connectors" for the ECLIPSE CERF. These connectors enable seamless data exchange and semantic interoperability among diverse energy apps, data sources, and interfaces. The three connector candidates discussed here come from:

1. **Generic Adapter (GA)** from the InterConnect project [1].
2. **EDDIE Connector** (deriving from OneNet [2]/EDDIE [3] work and contributed by D4G).
3. **Eclipse Semantic Modelling Framework (ESMF)** from the Eclipse Foundation [4].

Each connector has been analysed using documentation from their respective projects and contributions provided by project partners, as well as information gathered from the Eclipse Foundation.

The main objectives of this section are:

i. **Identify Suitable Connectors:** Present, analyse, and compare candidate connectors (e.g., from InterConnect, EDDIE, Eclipse Foundation ESMF) that can ease the integration of existing components and systems with the ECLIPSE CERF.

ii. **Map to High-Level Use Cases (HLUCs):** Show how each connector's capabilities align with specific HLUCs (e.g., economic/non-economic flexibility, device recommendations, grid alerts), ensuring the chosen solutions address the project's diverse pilot needs.

2.2.1. INTERCONNECT GENERIC ADAPTER (GA)

Before diving into detailed information about Generic Adapter, it's important to see how the Generic Adapter (GA) addresses semantic interoperability challenges within InterConnect. In the InterConnect project, legacy systems such as traditional APIs and devices need to communicate seamlessly. However, they do not inherently support semantic interoperability. To bridge this gap, a structured adaptation process is followed. First, the Service-Specific Adapter, or SSA, processes component-specific logic and maps API parameters. This ensures that data from different sources is standardized before further transformation.

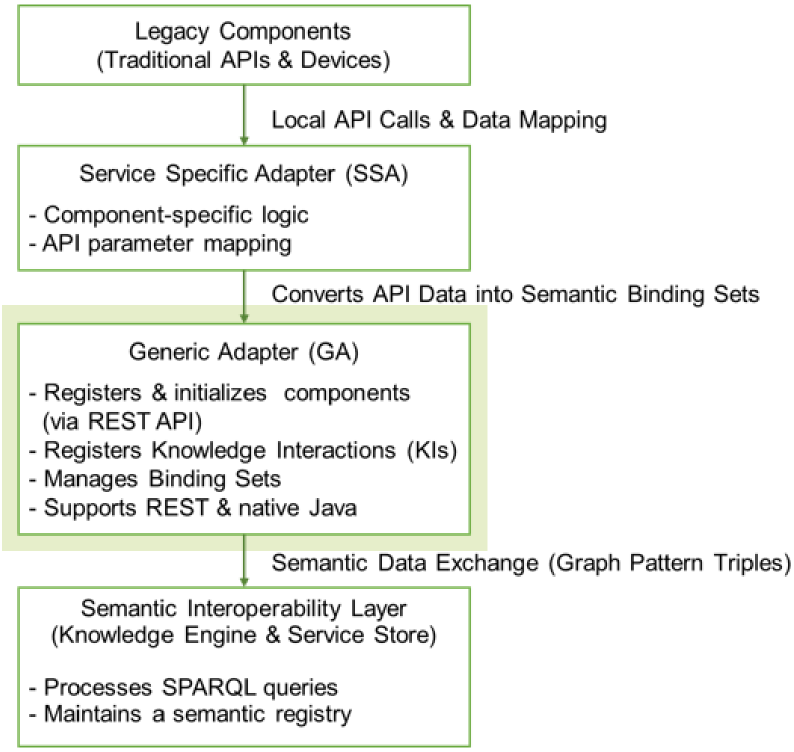


Figure: Enabling Semantic Interoperability Across Diverse Systems Using the Generic Adapter Connector.

Figure 1: InterConnect semantic interoperability framework

Next, the Generic Adapter, or GA, plays a crucial role in enabling interoperability. It registers and initializes components through REST APIs, manages Knowledge Interactions, and ensures data is transformed into structured semantic formats. It also supports REST and native Java, making it highly adaptable. Finally, the Semantic Interoperability Layer acts as the knowledge engine. It processes SPARQL queries and maintains a semantic registry, ensuring that data is stored and retrieved in a structured, meaningful way. After seeing how semantic interoperability is enabled in the InterConnect project, we will now dive deeper into the Generic Adapter (GA), one of the key components facilitating this process.

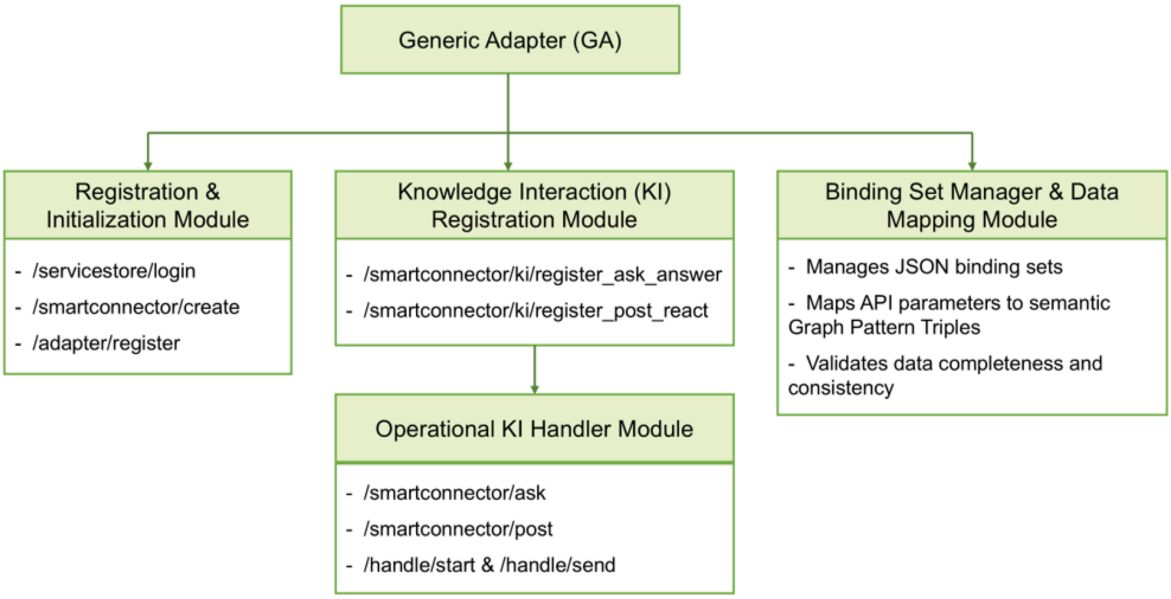


Figure: Generic Adapter.

Figure 2: InterConnect Generic Adapter (GA)

Generic Adapter plays a crucial role in enabling seamless communication between diverse systems by ensuring data interoperability. It consists of four main modules: First, it has the Registration & Initialization Module, which handles authentication, smart connector creation, and adapter registration. This ensures that components can securely connect and interact within the system. Next, the Knowledge Interaction Registration Module, which is responsible for registering interactions between components. It supports two key types of interactions ask-answer and post-react, allowing structured communication between services. Once registered, these interactions are executed through the Operational KI Handler Module. This module processes knowledge interactions by handling requests such as asking, posting, and executing actions. Finally, the Binding Set Manager & Data Mapping Module takes care of JSON binding sets, maps API parameters to semantic graph pattern triples, and ensures that the exchanged data is complete and consistent.

2.2.2. EDDIE CONNECTOR

The EDDIE Connector began its development within the OneNet project, whose goal was to unify Europe's electricity systems and promote real-time coordination among TSOs, DSOs, aggregators, and prosumers. In OneNet, the focus was on managing both validated historical data, vital for settlements and billing, and near real-time (NRT) data, essential for fast-response scenarios like balancing markets or flexibility services. By aligning with IEC 62325-351 [9] and IEC 62746 [10] standards, OneNet team ensured that all parties could exchange data in a common, machine-readable format. This groundwork demonstrated how aggregator-led demand-response interactions could function seamlessly under a single data infrastructure.

Building upon these foundations, EDDIE (European Distributed Data Infrastructure for Energy) emerged, refined by D4G to cover a broader, CIM-based range of energy data exchange scenarios. EDDIE significantly reduces data integration costs, allowing energy service companies to operate and compete seamlessly in a unified European market.

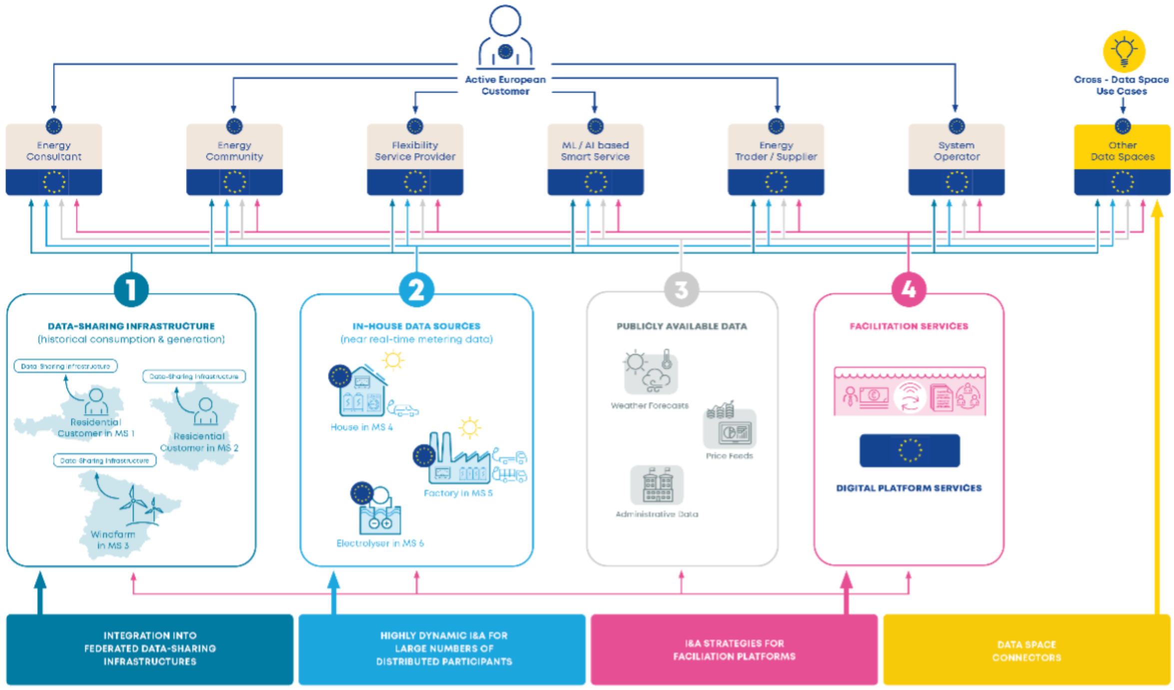


Figure 3: EDDIE Connector

As shown in Figure 3, EDDIE encapsulates four key building blocks. The first block supports the data applications to connect to existing regional infrastructure of the member states by providing validated historical data (VHD). Here, EDDIE acts as the technological layer that can be used to provide VHD to the eligible parties following the existing consent through the designated Permission Administrator of the member state. The second key component, an Administrative Interface for In-house Data Access (AIIDA), ensures secure and reliable access to valuable real-time data based on customer consent. It facilitates connections to in-house data assets, including the submeters, IoT devices, and others. Furthermore, AIIDA fetches data from the customer interface (e.g., P1) of the smart meters to provide near real-time data access to the data-based services. Additionally, EDDIE also provides connections to data marketplaces, other dataspaces, and public data.

Through a structured “Data-Sharing Infrastructure”, EDDIE defines how different Member States or grid operators can interconnect. It presents “Validated Historical Data (VHD)” profiles for regulated usage, “NRT” (near real-time) for aggregator-driven flows, and extended IEC 62325 parameters to handle consent and permission. By mapping all major domains (metering, flexibility bidding, scheduling) to the CIM classes, EDDIE enables domain-specific protocols like OCPP for EV chargers or OpenADR for demand response to run under one semantic umbrella.

In practice, EDDIE supports four main tasks. First, it covers FSP Registration, where aggregators sign up by providing baseline and resource data. Next, it channels validated historical data (VHD) for settlement or analytics. Third, it manages NRT data flows for aggregator-TSO processes, including baseline nomination and activation signals. Finally, it incorporates a robust consent model, ensuring prosumers or end-users can dynamically grant or revoke access to their energy data. These mechanisms have proven scalable across multi-country demonstrations, thanks to EDDIE’s approach of “regional connectors” that adapt local data sources to a universal CIM backbone.

2.2.3. ECLIPSE FOUNDATION SEMANTIC MODELLING FRAMEWORK (ESMF)

Eclipse Semantic Modelling Framework (ESMF) is designed to model aspects of digital twins, enabling the creation of APIs and UIs based on semantic information. ESMF focuses on digital twins, which are representations of assets using a set of submodels. Each submodel captures a specific aspect of the asset being modelled. For semantic interoperability, it is crucial to define the semantics of each submodel explicitly. ESMF provides tools and frameworks to define these semantics, ensuring interoperability and clarity in digital twin implementations.

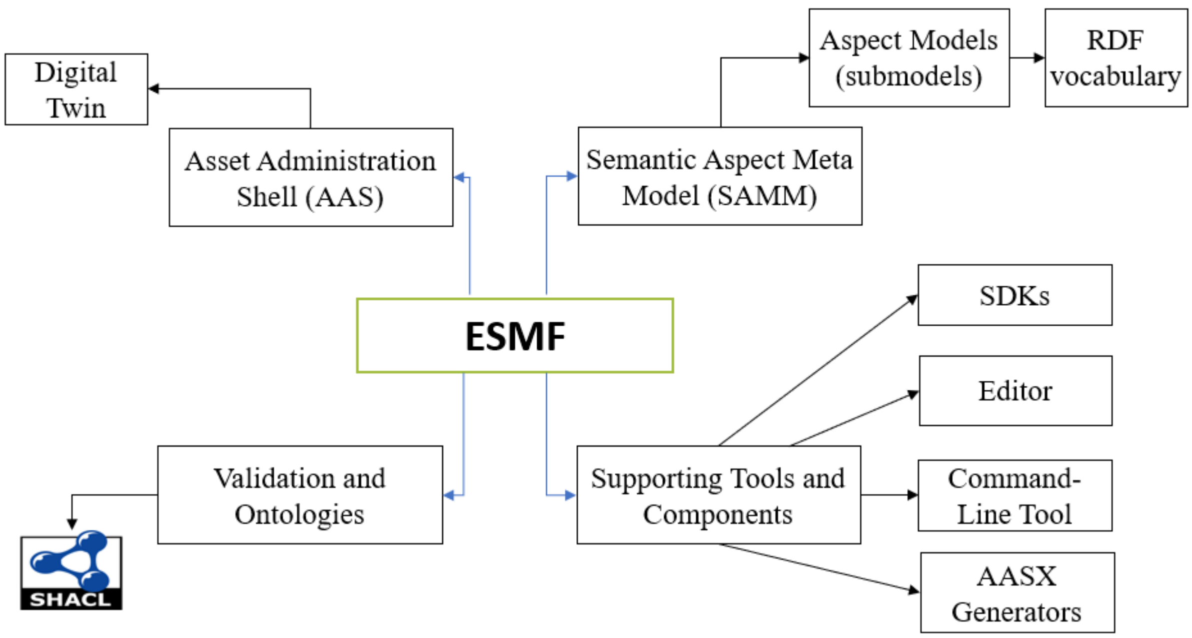


Figure: Core Components of Eclipse Semantic Modeling Framework.

Figure 4: Eclipse Foundation Modelling Framework (ESMF)

Figure 4 shows the main components of ESMF. At the core of ESMF is the Semantic Aspect Meta Model (SAMM), which provides a standardized language for defining the semantics of submodels also known as Aspect Models. These models define key parameters, such as a sensor's unit, range, and functionality, ensuring a structured representation. SAMM expresses these schemas using RDF vocabulary and validates them through SHACL rules, ensuring correctness and compliance with semantic standards. To facilitate usability, ESMF offers several supporting tools, including:

- SDKs for developers to integrate semantic models.
- An Editor that allows experts to create and edit Aspect Models visually.
- A Command-Line Tool for model validation, documentation, and conversions.
- AASX Generators, ensuring compliance with the Asset Administration Shell (AAS) standard for digital twins.

Validation plays a crucial role in ensuring accuracy and consistency. Aspect Models are checked against SHACL constraints, and structured ontologies are developed to maintain a common vocabulary, reducing ambiguity and ensuring smooth communication across different systems. Finally, ESMF seamlessly integrates with the Asset Administration Shell (AAS) a widely accepted standard for digital twins ensuring that all models it generates are compatible, structured, and industry-ready. This integration accelerates digital twin adoption and enhances their usability in industrial applications.

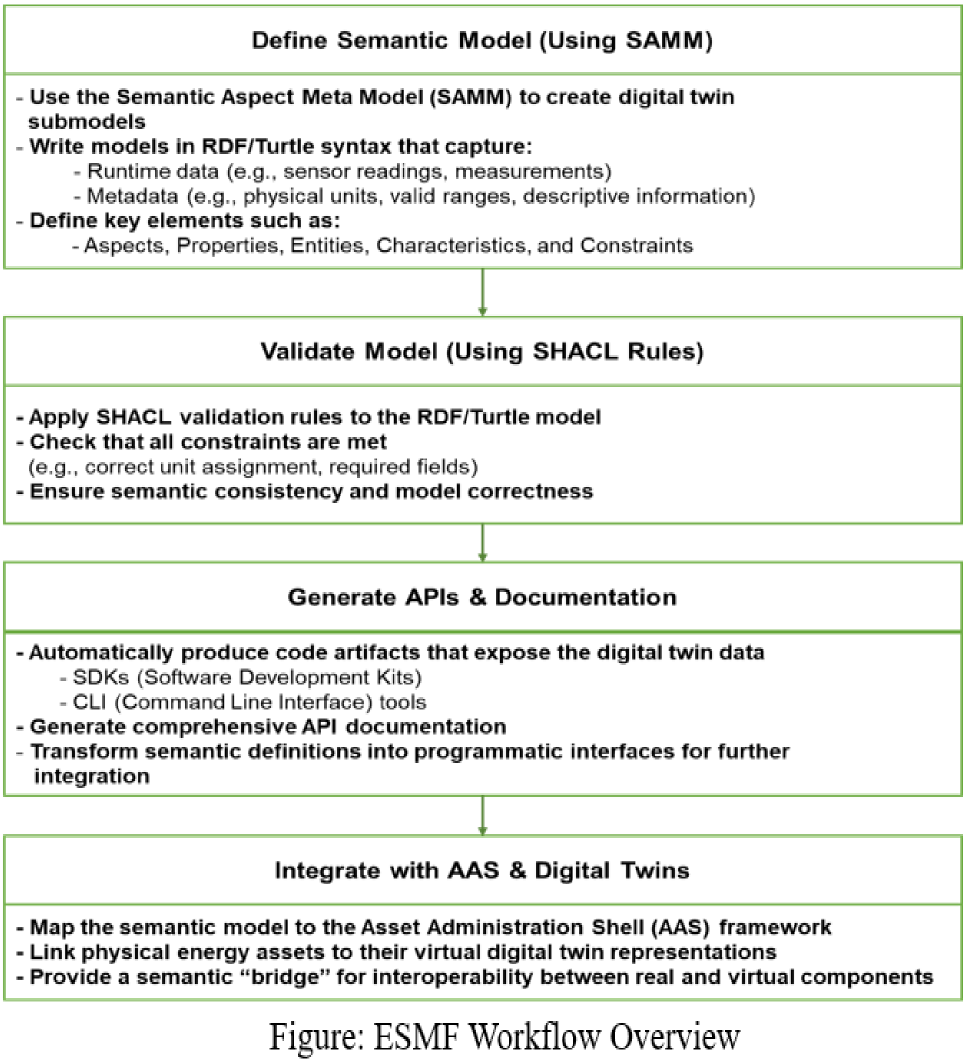


Figure 5: ESMF workflow overview

The workflow process, as shown in Figure 5, begins with defining the semantic model using the Semantic Aspect Meta Model (SAMM). This allows developers to create digital twin submodels, defining key aspects such as properties, entities, characteristics, and constraints. These models are expressed using RDF/Turtle syntax, capturing both runtime data (such as sensor readings) and metadata (like physical units and valid ranges). Once the models are created, ESMF ensures their correctness using SHACL validation rules. These rules check for semantic consistency, ensuring that constraints such as unit assignments and required fields are met. This step guarantees data reliability and compliance with industry standards. Next, ESMF automates the generation of APIs and documentation. The framework produces SDKs, command-line tools (CLI), and other software artifacts to make digital twin data accessible. It also transforms semantic definitions into programmatic interfaces, enabling smooth integration into various applications. Finally, ESMF integrates with the Asset Administration Shell (AAS) to connect real-world assets with their digital representations. This ensures that physical energy assets are linked to their virtual counterparts, providing a semantic bridge for interoperability. With this approach, organizations can develop scalable, efficient, and standards-compliant digital twins.

2.2.4. COMPARATIVE ANALYSIS AND MAPPING TO HLUCS AND PILOTS

After the description of the components, Table 1 compares the three connectors across multiple factors: technical scope, semantic standards, data exchange models, deployment complexity, maturity, and ecosystem readiness.

Table 1: Comparative analysis of software foundations

Factor	Generic Adapter (GA)	EDDIE Connector	Eclipse ESMF
Core Focus / Primary Role	Bridging service-specific adapters (SSAs) to a Knowledge Engine, enabling ontology-based data exchange (ASK/ANSWER, POST/REACT).	Standardizing energy data flows (historical, real-time, aggregator/DSO markets) via CIM alignment and ESMP-based message sets.	Enabling digital twin semantics using Aspect Models, validated by SHACL, with a strong tie-in to the Asset Administration Shell (AAS).
Key Standards & Protocols	• SPARQL-based KIs (via Knowledge Engine) • InterConnect Ontologies • Graph Pattern Triples • REST or Java integration	• IEC 62325, IEC 62746 • CIM (ENTSO-E) • ESMP Profile (VHD, NRT) • Potential synergy with OCPP, OpenADR	• RDF/Turtle, SHACL, SAMM • AAS alignment • Potential extension to domain ontologies • JSON/REST for aspects and submodels

Data Exchange Patterns	• Graph Pattern approach: binding sets map variables to values • Proactive (ASK/POST) & Reactive (ANSWER/REACT) interactions	• Validated Historical Data (VHD) for official meter readings • Near Real-Time (NRT) for aggregator-TSO/DSO interactions	• Aspect-based modelling: properties, operations, events • Runtime payloads enforced by SHACL rules • Generates OpenAPI/JSON schemas from semantic models
Semantic Depth / Modelling	• Primarily focuses on structure of interactions (KIs) rather than comprehensive domain modelling	• Uses CIM-based domain definitions (esp. for DSOs, TSOs) • Maintains comprehensive domain coverage for flexible markets	• Deep, hierarchical semantic modelling with submodels • Highly robust SHACL-based validation and inheritance rules • Focused on digital twin representation
Deployment Complexity	• Requires a Knowledge Engine (smart connectors, Service Store) • Typically deployed as a separate service or Java process	• EDDIE runs as a CIM-based connector or library that can integrate with aggregator/DSO systems • Must handle consent management data flows	• ESMF usage involves creating and maintaining Aspect Models • Tools needed: Editor, CLI, AAS environment (if used) • Possibly bigger overhead for domain modelling

Integration Overhead	• Moderate, GA approach is well-documented, but user must define SSAs and map local APIs to Graph Patterns	• Medium-High, must align local data with EDDIE's CIM profiles. Very comprehensive but can be more complex to set up	• Medium-High, Users must design aspect models, handle SHACL validation, etc. Excellent for new developments, but more overhead for legacy systems
Maturity & Field Testing	• Used extensively in InterConnect demos/pilots • Has stable references, e.g., documented on GitLab, used by multiple SSAs	• Validated in OneNet, EDDIE, and D4G contexts • Specific TSO pilot integrations (Estonia/Elering) for balancing markets	• Open-source Eclipse project • Emphasis on industrial digital twin synergy • Maturity is good within digital manufacturing/automation contexts
Recommended Use Cases	• Rapid bridging for legacy devices/apps to a semantic environment • Multi-SSA scenarios with minimal domain-level modelling required	• Full aggregator/DSO/TSO flow (historic & NRT data, market transactions) • Demand response, consent management, advanced energy markets	• Digital twin ecosystems • Complex semantic scenarios needing domain submodels, validation, and advanced data constraints

Pros / Strengths	• Easy to add new SSAs • Good error checking on bindings • Clear "ASK/ANSWER" • Reusable architecture	• Thorough coverage of flexibility & real-time use cases • Standard-based approach for aggregator-operator interactions • Consent management is built-in	• High-level semantic rigor (SHACL, RDF) • Extensive tooling for digital twin aspects • Deep structural modelling and validation
Cons / Limitations	• Lacks direct domain coverage for energy-specific models (depends on external ontology definitions)	• Complexity can be high if smaller-scale usage • Mostly specialized for aggregator/flex markets	• Overhead in defining aspect models • Possibly over-engineered if only minimal data integration is needed
License / Openness	• InterConnect open-source components (Apache-2.0 [11]), GA specs are publicly available on GitLab	• D4G-based EDDIE solution references open CIM standards, docs available to partners & EU collaboration	• Eclipse Foundation open-source license (MPL-2.0 [12]), fully public repos, active developer community

ECLIPSE project defines a set of High-Level Use Cases (HLUCs), each potentially involving multiple pilots. Table 2 proposes how these three connectors might best support each HLUC, accompanied by pilot examples.

Table 2: Mapping of software foundations vs. HLUCs and pilots

HLUCs	Description	Potential Connector Fit	Examples
HLUC1	Encourages consumer demand shift via price signals, financial rewards, tariff switching	• EDDIE: Good for aggregator/DSO data (real-time signals, metering) • GA: Could integrate consumer-facing apps easily • ESMF: If advanced digital twin modelling is needed	Austrian Pilot (Price-driven aggregator scenario) might rely on EDDIE to handle official meter data and aggregator bidding. GA can also link small-scale consumer apps. ESMF adds deeper modelling only if needed (e.g., a digital twin of the home).

HLUC2	Focus on voluntary shifts via gamification, CO_2 footprint, badges, or social recognition	• GA: Quick bridging for user-facing app notifications • ESMF: If we want digital twin data about device usage or occupant patterns	Spanish Pilot (Non-financial EV-charging incentives). If more complex occupant-level modelling is required, ESMF can help. If only simple app communication is needed, the GA might suffice.

HLUC3	Educates consumers about new technologies, efficiency potential, ROI of adoption	• EDDIE: Might help gather official data from DSOs to estimate ROI • ESMF: Detailed digital twin approach for device modelling • GA: Quick aggregator - knowledge-engine link	Bulgarian Pilot might use EDDIE for existing meter data and ESMF for modelling new home devices. Meanwhile, the GA would be enough if just bridging a single aggregator or consumer portal to a knowledge engine.
HLUC4	DSOs or TSOs broadcast urgent signals to reduce or shift load in critical times	• EDDIE: Strong real-time data flows for aggregator/DSO • GA: Provides a straightforward channel to push notifications to apps	Swedish Pilot (Grid vulnerability in southern region). EDDIE can handle TSO-based real-time signals. GA can integrate smaller local devices. ESMF is optional unless the pilot needs to thoroughly model assets' states over time.

HLUC5	Broad consumer guidance without direct financial or DR signals	• GA: Easiest if tips are short semantic messages • ESMF: If the pilot wants a deeper twin approach that tracks changes in building insulation or occupant behaviour	Polish Pilot might rely on GA for simple push messages to consumer apps. If the pilot aims for sophisticated building-level models (like occupant comfort modelling), ESMF can come into play. EDDIE is less relevant unless real-time DSOs data is needed.

2.3. GOVERNANCE SCHEME

A robust governance architecture is the cornerstone of any functional data space. It lays down the essential rules and formal agreements that enable such ecosystems to evolve beyond theory and support active, trust-based collaboration. The primary goal of this governance is to create an environment of operational certainty, allowing all participants to share data securely. This means directly addressing the intrinsic difficulties of data exchange, from ensuring technical systems can communicate seamlessly to harmonizing data definitions and untangling the complexities of cross-border legal compliance.

In recognition of this, several key initiatives are pioneering the principles of data space governance. Today's landscape is not characterized by a single, monolithic model, but by a variety of foundational frameworks being applied and adapted in different sectors. This section examines these evolving structures, starting with the conceptual approaches of the International Data Spaces Association (IDSA) and Gaia-X. From there, it offers a practical comparison of how these frameworks are being implemented on the ground in specific energy data space projects, such as Enershare and SYNERGIES, to showcase their unique strategies.

2.3.1. IDSA GOVERNANCE FRAMEWORK OVERVIEW

2.3.1.1. FUNCTIONAL GOVERNANCE LAYERS

According to their publication [13], the IDSA governance model is structured around four functional layers which align with the European Interoperability Framework [14] and the Open DEI [15] principles.

- **Technical Layer:** Ensures the secure and sovereign exchange of data through components like IDS Connectors, identity provisioning (DAPS, ParIS), and policy enforcement mechanisms. Governance at this level includes standardization of communication protocols (e.g. IDSCP), certification of components and hybrid handshake capabilities to accommodate various data security requirements.
- **Semantic Layer:** Supports shared understanding of data meaning. Recognizing that a universal semantic model is often unrealistic, the framework promotes the development and use of semantic management data apps and conversion tools that allow interoperability between diverse domain-specific ontologies.
- **Organizational Layer:** Aligns business processes, responsibilities, and stakeholder interactions. Governance mechanisms here include onboarding procedures, certification of participants, service level agreements (SLAs), and operational workflows – ensuring all actors follow common standards for reliability and quality.
- **Legal Layer:** Addresses cross-jurisdictional data sharing by enforcing legal interoperability. Joint legal agreements and real-time validation of legal status are core elements. This ensures consistent policy

enforcement across different data spaces and supports auditability, compliance and trust.

These layers are embedded under an integrated governance approach, referred to as the “soft infrastructure” of European data spaces, supporting both, intra and inter data space interoperability:

- **Intra Data Space Governance:** Addresses the internal structure of a single data space instance. It governs interactions between the data space authority, data processing units and data sharing infrastructure. It includes establishing identity, enforcing access policies and ensuring semantic alignment across participants.
- **Inter Data Space Governance:** Addresses interoperability across multiple, federated data spaces. It emphasizes hybrid connectors, federated catalogues, policy harmonization and shared identity attributes across governance domains. Inter data space governance, applied across all functional layers, is critical for building the Common European Energy Data Space (CEEDS) and supporting cross-sector data exchange scenarios.

The distinction is crucial. While intra governance ensures local compliance and integration, inter governance creates the foundation for pan-European, cross-domain collaboration and innovation.

2.3.1.2. INCENTIVE MECHANISMS

The IDSA does not provide official documentation or proposals on the mechanisms to incentivize asset exchanges within data spaces. Nevertheless, in the next sections are three main types of incentive mechanisms considered which are described next [5] [16]:

- **Data-by-currency:** Data owners share data for monetary compensation based on its relevance to analytics/optimization tasks.
- **Data-by-data:** Barter trading involves data exchange for non-monetary compensation, with data owners agreeing to share and receive data of equal value.
- **Data altruism:** Individuals and companies voluntarily provide data for public use.

2.3.2. GAIA-X

This initiative aims to create a federated open data infrastructure based on European values regarding data and cloud sovereignty. The mission is to design and implement a data sharing architecture with common standards, best practices, tools, and governance mechanisms [17].

2.3.2.1. ALIGNMENT WITH THE IDSA GOVERNANCE FRAMEWORK

- **Technical Layer:**
  - **Inter Data Space Connection:** Interoperability and interconnection is realized using so called Federation Services to provide data sovereignty and trust between and among participants [17].
  - **Identity and Access Management:** Gaia-X uses existing identities with unique identifiers and attributes for access control. The Gaia-X Trust Framework ensures trust through cryptographic verification, and a two-tiered approach to Identity and Access Management is recommended, with Self-Sovereign Identity (SSI) for interoperability and underlying technologies for federated access [17].
  - **Standardization:** The Gaia-X Trust Framework validates automatically enforceable rules for Self-Description compatibility, including syntactic correctness, schema validity, cryptographic signature validation, attribute value consistency, and attribute value verification. Verification is performed using Verifiable Credentials from the Gaia-X association or Trusted Data Source owners [17].
  - **Component Certification:** Component certification in Gaia-X is handled via Verifiable Credentials issued by trusted Conformity Assessment Bodies (Trust Anchors), embedded in Self-

Descriptions and validated by the Gaia-X Compliance Service [17].

- **Semantic Layer:**
    - **Discoverability:** Gaia-X enables interoperable discoverability through Federated Catalogues which index and expose Self-Descriptions for services and resources in a unified manner. Furthermore, Self-Descriptions are based on W3C Verifiable Presentations [18] and JSON-LD [19] with Verifiable Credentials [20] ensuring interoperability.
    - **Data Exchange:** The data exchange service manages the functionalities used for controlled data exchange including applied schemas, protocols and usage policies [17].
- **Organizational Layer:**
    - **Lifecycle governance:** User lifecycle management includes validation and signing via Gaia-X Trust Framework as well as certificate and key revocation by the entities involved [17].
    - **Operational governance:** The operational governance is applied using transparent rules, traceability for interactions and support for requirements (e.g. SLA) using policies [17].
    - **Certification governance:** Certification and compliance is regulated and ensured via the Gaia-X Compliance Service which is integrated to the Gaia-X Trust Framework [17].
- **Legal Layer:**

- **Interoperability:** The Gaia-X Self-Description does not contain full contract management rules but may reference relevant usage policies or terms. Contract management is handled separately through dedicated legal roles (licensor/licensee) who define the conditions for service usage. Gaia-X supports Computable Contracts to enable interoperability and automation by expressing agreements in a machine-readable, enforceable format. These contracts operate alongside Self-Descriptions but are not embedded within them [17].
- **Auditability:** Auditability in Gaia-X is achieved through the combination of W3C Verifiable Credentials and the smart contract functionality of the Gaia-X Registry, enabling verifiable claims, automated rule enforcement, and immutable trace logs [17].
- **Cross-Jurisdictional Policy:** Cross-jurisdictional restrictions are enforceable through usage policies attached to requested resources within Gaia-X. These policies can include constraints such as geographic location, regulatory compliance, or contractual obligations, and are part of the Self-Descriptions associated with Service Offerings and Resources [17].

2.3.2.2. INCENTIVE MECHANISMS

As stated in "Gaia-x Architecture Document" [17], Gaia-X motivates the creation of decentralized autonomous ecosystem whose goal is, besides others, to incentivize its community members through a set of automatically enforceable rules. However, Gaia-X does not define incentive mechanisms to apply on their framework.

2.3.3. MAPPING EXERCISE OF FEW DATASPACES TO IDSA

Additionally, we commenced an exercise to map few dataspace models to IDSA structure. These are summarised below:

2.3.3.1. ENERSHARE

Enershare [7] is a Horizon Europe project designated to create an Energy Data Space (EDS). It supports both regulated (DSOs, TSOs) and non-regulated (aggregators, communities, consumers) stakeholders. The project enables trusted, participatory and economically viable data exchange across the energy value chain with technical and governance alignment to IDSA principles.

2.3.3.1.1. ALIGNMENT WITH THE IDSA GOVERNANCE FRAMEWORK

- **Technical Layer:**
    - **Inter Data Space Connection:** In Enershare, Inter Data Space Connections are handled via IDSA-compliant data space connectors that enforce identity, access, and usage policies

through the Dataspace Protocol, enabling secure and interoperable federation of distributed energy platforms [21].

- **Identity and Access Management:** Enershare handles Identity and Access Management (IAM) using decentralized identity principles (DID, VC) and IDSA/GAIA-X-compliant components like DAPS and certificate authorities, enabling secure, sovereign data exchange through policy-based access control and federated connectors [21].

- **Standardization:** Enershare ensures technical layer standardization in line with IDSA by implementing federated data space connectors, standardized vocabularies (e.g., CIM, SAREF), and interoperable protocols (e.g., dataspace protocol), supported by access control, identity management (DAPS, CA), and machine-readable contract policies via components like the Clearing House and Vocabulary Hub [21].

- **Component Certification:** Enershare handles certification through IDSA-compliant mechanisms, using components like the Certificate Authority (CA) and Dynamic Attribute Provisioning Service (DAPS) to authenticate connectors and manage trusted organizational identities via Verifiable Credentials and Decentralized Identifiers (DID) [21].

- **Semantic Layer:**
  - **Discoverability:** Enershare uses the Open Energy Ontology (OEO) to model energy-related concepts such as renewables, electromobility, and energy communities. OEO extends existing

semantic standards like SAREF and integrates domain-specific vocabularies including CIM, COSEM, and IEC 61850. This harmonized approach supports standardized interpretation and enhances the discoverability of concepts across the energy domain. Additionally, a Vocabulary Hub enables the mapping and alignment of ontologies and semantic assets, further facilitating the discovery and reuse of semantic resources across data spaces [16] [21] [22].

  - **Data Exchange:** Semantic interoperability is supported by management tools and data apps for ontology alignment and semantic conversion. These tools support mapping, data annotation, and transformation between different vocabularies, facilitating data integration and exchange [22]. Inter data space connections are made possible through IDS connectors, which enable secure and trusted one-to-one data exchanges [22] [13]. For broader distributions, a one-to-many exchange model using a Context Broker is proposed, enabling efficient publish/subscribe mechanisms across federated participants [22] [21].

- **Organizational Layer:**
  - **Lifecycle governance:** Enershare implements IDSA lifecycle governance through decentralized identity management, structured onboarding and offboarding, and policy-based access control. A dedicated governance authority and transaction logging via a Clearing House ensure secure,

sovereign, and interoperable data exchange within the energy data space [21].

- **Operational governance:** Enershare implements operational governance aligned with IDSA by using secure identity and access management (DID, DAPS), machine-readable usage policies and federated data connectors to ensure sovereign, auditable data exchange [21].
- **Certification governance:** Enershare aligns with IDSA and GAIA-X by using standardized identity management (e.g. Keycloak, DAPS, DID), enforcing access control through trusted connectors and policies, and ensuring traceability via a Clearing House. This enables secure, certified participation in CEEDS with verifiable identities and contract-based governance [21].

- **Legal Layer:**
  - **Interoperability:** Enershare handles legal interoperability by adopting the IDSA governance model with decentralized and federated authority structures, ensuring enforceable contracts and compliance with EU regulations like GDPR and the Data Governance Act to support cross-border energy data exchange [16].
  - **Auditability:** Enershare ensures auditability through conformance to IDSA by enforcing multilateral agreements, data usage policies and roles like the Clearing House for logging and provenance tracking, enabling traceable and compliant data transactions [16].

- **Cross-Jurisdictional Policy:** Enershare addresses cross-jurisdictional policy challenges by conforming to IDSA's governance model and decentralized trust mechanisms, ensuring compliance with both EU-wide and national laws through adaptive legal monitoring and standardized contracts [16].

2.3.3.1.2. INCENTIVE MECHANISMS

According to [16], the goal of the Enershare project is to provide a set of incentive mechanisms for data sharing in the B2B domain. The focus hereby is to attract data consumers while increasing the revenue and benefits for data sellers. To achieve this, following incentive mechanisms are conceptualized:

- **Data-by-currency**
- **Data-by-data**

2.3.3.2. SYNERGIES

The SYNERGIES Energy Data Space [8] is a secure, interoperable environment that empowers energy stakeholders, especially consumers, to share, access, and monetize energy data while preserving sovereignty and trust. It enables AI-driven services, flexibility optimization, and cross-sector integration to support a resilient, consumer-inclusive energy transition.

Validated in real-world pilots across Europe, it serves as a reference model for collaborative energy data ecosystems [23].

2.3.3.2.1. ALIGNMENT WITH THE IDSA GOVERNANCE FRAMEWORK

- **Technical Layer:**
    - **Inter Data Space Connection:** The inter-data space connection in the SYNERGIES architecture is established through peer-to-peer communication between different energy data spaces, which is orchestrated and managed via the SYNERGIES Centralized Cloud. This setup allows multiple data spaces (e.g. from multiple edge devices, centralized cloud or on-premises infrastructure) to interoperate securely and efficiently [23].
    - **Identity and Access Management:** Access to the SYNERGIES Energy Data Space is organization-based, with the organization manager registering the team and managing member roles. The SYNERGIES admin reviews and approves access, which can be revoked at any time. Users access all SYNERGIES services via single sign-on after registering through the central platform [23].
    - **Standardization:** The SYNERGIES project promotes standardization using open protocols like IDS, IoT, OPC-UA and Modbus for data ingestion from legacy systems and individual devices. It also aligns with European frameworks such as GAIA-X, IDSA and DERA 3.0 to support trusted data governance,

dynamic access control and standardized smart contracts to enable secure, interoperable and sovereign energy data sharing [23].

  - **Certification:** SYNERGIES includes a Data Certification Service that ensures data quality, trust, and compliance before it is shared. This service verifies and certifies incoming data assets, working alongside observability and curation tools to maintain data integrity [23].

- **Semantic Layer:**
  - **Discoverability:** Publication and Discovery services act as intermediaries in a Data Space, enabling participants to find each other's data and services. They operate through a central or decentralized catalogue where offerings are described using Self-Descriptions [23]. However, the standardization details of these Self-Descriptions are not specified.
  - **Data Exchange:** SYNERGIES provides a semantic data exchange framework based on open standards (e.g., IEC 61970/61850, SAREF, IFC, OCPP) to harmonize and reconcile incompatible data models across the energy and related sectors. This is achieved through the SYNERGIES Network of Sectorial Data Models, which supports semantic mapping by data providers and is continuously updated through life-cycle management mechanisms [23].
- **Organizational Layer:**

- **Lifecycle governance:** SYNERGIES defines structured procedures for onboarding and managing participants, ensuring trusted, role-based access to each organization's Energy Data Space. The Security, Authentication & Authorization Engine governs this lifecycle across all services, from registration and verification to deactivation, enforcing organization-scoped access, role hierarchies, and single sign-on functionality [23].
- **Operational governance:** Operational governance in SYNERGIES ensures that all participants follow standardized processes for data handling, collaboration, and service execution. Through components like the Smart Contract Management Engine and the Contract Settlement Engine, agreements on data sharing, access control, and service levels are formalized, monitored, and enforced. Organizational workflows are supported by structured templates for ingestion, analytics, and asset publication, ensuring consistent quality, auditability, and compliance with interoperability and trust frameworks [23].
- **Certification governance:** The Data Certification Service validates the provenance and integrity of shared data, tagging assets with trust metadata to support secure exchange. These mechanisms allow only authorized and certified actors to extend shared structures, maintaining semantic consistency and interoperability across the Energy Data Space [23].

- **Legal Layer:**

- **Interoperability:** SYNERGIES addresses legal interoperability by aligning with EU frameworks like the Data Governance Act [24] and AI Act [25], aiming to standardize data-sharing rights, contracts, and governance across stakeholders. Key legal barriers include fragmented regulations, unclear data ownership, and the lack of machine-readable contract templates. The project promotes trust, sovereignty, and compliance in energy data exchange through harmonized legal frameworks and roles [23].

- **Auditability:** SYNERGIES ensures auditability by using encrypted smart contracts and a distributed ledger to securely manage and trace data sharing agreements. It includes detailed logging of data ingestion and analytics processes to support full traceability. Additionally, ethical AI assessment tools and continuous monitoring of access policies help ensure transparency and accountability across the platform [23].

- **Cross-Jurisdictional Policy:** In SYNERGIES, cross-jurisdictional restrictions are handled through a data-sovereignty-preserving architecture, where data owners define access and usage policies during the design phase. These policies are enforced through formalized data contracts and supported by mechanisms for secure, federated data sharing, including peer-to-peer transactions and encrypted exchanges. The architecture accommodates several deployment scenarios ensuring compliance with location-specific or regulatory constraints defined by the data provider's preferences or applicable local legislation [23].

2.3.3.2.2. INCENTIVE MECHANISMS

As illustrated in [23], the Contract Settlement Engine is responsible for establishing agreements between two or more parties on behalf of smart contracts. It supports — at a minimum, as no additional mechanisms are mentioned in the document — two specific incentive models for the exchange of data assets, each governed by predefined and mutually agreed-upon rules:

- **Data-by-currency**
- **Data-by-data**

2.4. STAKEHOLDER'S ENGAGEMENT PLAN

This section presents a detailed elaboration of pilot site questionnaires developed for the 13 demonstrations (demos) conducted across Europe. These demos serve as localized testbeds for evaluating how tailored digital tools, user engagement strategies, and interoperable data systems can empower consumers, support flexibility services, and strengthen grid resilience.

Each pilot is led by a national project partner, ranging from transmission and distribution system operators to aggregators, research institutions and technology providers, who define, implement, and evaluate high-level use cases (HLUCs) in collaboration with local stakeholders. The pilots cover a broad geographic and regulatory spectrum, including France, Austria, Spain, Bulgaria, Slovenia, Cyprus, Greece, Sweden, Portugal, Croatia, Czech Republic, Poland, and Romania.

This chapter consolidates information on Stakeholders' engagement and risk mitigation strategies for each demo. The insights derived will support cross-comparison, inform the development of shared tools and frameworks, and guide the scalability and replicability of ECLIPSE solutions across the European energy landscape.

2.4.1. DEMO #1 (FRANCE)

Pilot leader: Voltalis

Supporting partner: D4G

2.4.1.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The French Demo #1 targets 2 main stakeholder groups:

a. Residential consumers (ResC) providing access to dynamic energy management tools via Voltalis APP, and delivering:
    - Participation in energy markets through an aggregator.
    - Potential cost savings and environmental benefits.

b. Energy market actors (EMA) validating scalable commercial models for flexibility:

  - Insights into consumer behaviour and engagement strategies.

2.4.1.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan incorporates the Interface App, physical/digital get-togethers, newsletters, and bilateral interaction to inform, engage, and empower ResC and EMA. Awareness building, updating, and feedback capture are achieved through trusted channels, guaranteeing user-driven development and continuous responsiveness to stakeholder needs.

Table 3: Demo #1 (France) stakeholders' engagement plan

Activity	Target stakeholder	Description
Interface APP	ResC	Main digital touchpoint for information, participation, and control.
Physical & digital meetings	All	Workshops & info sessions to introduce ECLIPSE features and benefits
Newsletters & Campaigns	ResC	Providing updates on demo progress, tips, and engagement calls

Bilateral communications	All	Using trusted and familiar Voltalis channel streams
Co-creation feedback	ResC	Collect feedback to improve user experience and align features with needs

This engagement plan covers:

- ✓ Awareness through informing consumers about ECLIPSE and their role;
- ✓ Activation due to enhancing onboarding through intuitive tools and communication; and
- ✓ Retention via sustained participation via value-added services and feedback mechanisms.

2.4.1.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To address key risks, the plan includes incentives and intuitive UI to boost consumer engagement, while technical delays are mitigated through coordination between Voltalis and development teams. Privacy concerns are handled with transparent data policies, consent mechanisms, and full

GDPR compliance, ensuring user trust and smooth integration of the platform's features.

Table 4: Demo #1 (France) risk considerations and mitigation measures

Risk	Mitigation measure
Low consumer engagement	Incentivization, clear messaging on benefits and user-friendly, easy-to-use UI.
Delays regarding technical integration	Close coordination between Voltalis and WP4 technical teams.
Privacy / data protection concerns	Transparent data policies, consent management and GDPR compliance

2.4.2. DEMO #2 (AUSTRIA)

Pilot leader: FHOOE (University of Applied Sciences Upper Austria)

2.4.2.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Austrian Demo #2 targets 3 main stakeholder groups:

a. Residential prosumers (ResP) providing access to personalised energy insights, and delivering:
    - Participation in energy flexibility schemes;
    - Potential energy savings and empowerment.
b. Energy Community operators (ECo) managing member engagement and energy flows:
    - Identifying new members via marketplace;
    - Operation efficiency;
    - Insights into consumer behaviour and engagement strategies.
c. System Operators (SOs) by aligning data flows, and interoperability for establishing technical specifications.

2.4.2.2. STAKEHOLDERS' ENGAGEMENT PLAN

The stakeholder engagement plan includes targeted outreach, such as advertising, email campaigns, and app notifications, for ResP, as well as direct communication and onboarding for SO and ECo. Workshops, bilateral channels, and marketplace integration ensure all stakeholders are informed, engaged, and aligned around data sharing, interoperability, and the benefits of digital energy tools.

Table 5: Demo #2 (Austria) stakeholders' engagement plan

Activity	Target stakeholder	Description
Targeted advertising	ResP	Email campaigns, app onboarding materials, and digital guides
Direct engagement with EC operators	ECo, SO	Meetings and targeted outreach to selected community operators
Workshops, webinars	All	Co-learning sessions to introduce tools and discuss needs.
Bilateral communications	All	Using trusted and familiar channel streams
APP notifications	ResP	Integrated tips and updates to promote engagement
Marketplace integration campaign	All	Promoting features that connect consumers and operators via digital tools

DSO onboarding	SO	Promoting the capability regarding data sharing and interoperability facilitation

This plan brings:

- ✓ Trust through direct and transparent communication;
- ✓ Convenience through digital interactions; and
- ✓ Engagement through co-design and shared ownership of outcomes.

2.4.2.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To mitigate engagement and technical risks, the plan focuses on identifying motivated communities early and demonstrating clear benefits. Simplified onboarding processes and dedicated support help address integration challenges, while alternative formats like call support and in-person briefings ensure accessibility for users with low digital literacy.

Table 6: Demo #2 (Austria) risk considerations and mitigation measures

Risk	Mitigation measure

Limited interest from small ECs	Early identification of motivated ECs, clear demonstration of benefits.
Technical onboarding difficulty	Simplified onboarding flows, user support services.
Low digital literacy	Provide alternative formats (e.g., call support, in-person briefings).

2.4.3. DEMO #3 (SPAIN)

Pilot leader: i-DE

Supporting partner: AELEC

2.4.3.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Spanish Demo #3 targets 3 main stakeholder groups:

a. Residential consumers (ResC) providing improved tariffs via active flexibility participation and assisting in contributing to sustainability goals;

b. Employees (E), by involving a leading smart grid project, enhancing awareness of personal energy impact, managing member engagement and energy flows.

c. Fleet vehicles (FV) by aligning data flows, and interoperability for establishing technical specifications.

2.4.3.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement strategy combines physical meetings, demonstrations, and feedback sessions to inform all stakeholders about use cases and benefits. Internal campaigns target employees and field staff, while customer demos raise awareness among residential consumers. Broader communication is ensured through partnerships and industry associations, fostering consistent outreach and sector-wide alignment.

Table 7: Demo #3 (Spain) stakeholders' engagement plan

Activity	Target stakeholder	Description
Physical meetings	All	Face-to-face presentations and Q&A sessions to explain UCs and benefits.

Internal campaigns	E, FV	Communications via newsletters and HR-led briefings.
Customer demonstrations	ResC	Demo showcases to raise awareness about tariff and energy options
Feedback sessions	All	In-person and digital channels to gather feedback
Partnership communication	All	Sector-wide dissemination through association-led channels and events

2.4.3.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To overcome limited interest and onboarding challenges, the plan includes incentives, gamification, and clear communication tailored to employees and field staff. Technical topics are simplified using everyday language, and data-sharing concerns are addressed through strict GDPR compliance and transparent opt-in procedures to build trust and encourage participation.

Table 8: Demo #3 (Spain) risk considerations and mitigation measures

Risk	Mitigation measure

Limited interest from E and FV	Incentives, gamification, internal campaigns to drive participation
Technical onboarding difficulty	Clear benefit framing and use of everyday language during outreach.
Data-sharing unwillingness	GDPR compliance and opt-in frameworks.

2.4.4. DEMO #4 (BULGARIA)

Pilot leader: ESO (Electricity System Operator – Bulgaria)

Supporting Partner: ETRA

2.4.4.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Bulgarian Demo #4 targets 2 main stakeholder groups:

a. Residential consumers (ResC) providing access to personalized energy insights;

b. Small businesses (SMEs), providing energy efficiency consulting tailored to SME needs, and supporting them to reduce operational costs through better energy practices,

2.4.4.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan uses a web platform, newsletters, and social media to deliver energy-saving tips, updates, and build pilot visibility. Direct outreach through ESO leverages trusted communication channels to reinforce messages and drive stakeholder engagement across all user groups.

Table 9: Demo #4 (Bulgaria) stakeholders' engagement plan

Activity	Target stakeholder	Description
Mobile APP	All	Primary tool for delivering energy-saving advice and demo updates.
Newsletters	All	Periodic updates on pilot progress, new app features, and energy insights.
Social media campaigns	All	Public campaigns to promote pilot and drive platform traffic.

2.4.4.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To address low user engagement and limited digital literacy, the strategy includes interactive content such as videos, tips, and comparisons. Alternative formats like call support and in-person briefings ensure accessibility, while the platform is designed for clarity and ease of use to support broad user participation.

Table 10: Demo #4 (Bulgaria) risk considerations and mitigation measures

Risk	Mitigation measure
Low user engagement	Use engaging formats including videos, tips, and comparisons.
Low APP adoption	Intuitive design, incentivization, and consistent communication.

2.4.5. DEMO #5 (SLOVENIA)

Pilot Leader: Elektro Ljubljana (EL)

2.4.5.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Slovenian Demo #5 targets 2 main stakeholder groups:

a. Residential consumers (ResC) providing insight into their energy usage across different net usage schedules and energy efficiency activities;

b. RES prosumers (RESp), energy monitoring of different net usage tariffs and energy efficiency activities.

2.4.5.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan centres on a mobile app for interaction, updates, and data access, supported by digital campaigns and newsletters to inform users about progress and features. Engagement events such as workshops and webinars foster trust and enable direct feedback, ensuring broad and active participation across all stakeholder groups.

Table 11: Demo #5 (Slovenia) stakeholders' engagement plan

Activity	Target stakeholder	Description
Mobile APP	All	Main tool for ongoing engagement, data visualization, and feature access.

Digital Campaigns	All	Outreach through social media and energy-related newsletters.
Newsletters	All	Periodic updates on pilot progress, new app features, and energy insights.
EC engagement events	All	Local workshops or webinars to build trust and collect real-time feedback.

2.4.5.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To boost app adoption and user understanding, the strategy includes intuitive design, incentives, and regular communication. Net usage complexities are addressed through clear visualizations and in-app educational content. For users with low digital literacy, alternative support channels such as phone assistance and in-person briefings are provided to ensure accessibility.

Table 12: Demo #5 (Slovenia) risk considerations and mitigation measures

Risk	Mitigation measure
Low APP adoption	Intuitive design, incentivization, and consistent communication

Confusion due to net usage regimes	Clear visualizations and educational materials included in the APP
Low digital literacy	Provide alternative formats (e.g., call support, in-person briefings).

2.4.6. DEMO #6 (CYPRUS)

Pilot Leaders: TSOC (Transmission System Operator Cyprus), CINTECH

Supporting Partner: ETRA

2.4.6.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Cypriot Demo #6 targets 2 main stakeholder groups:

a. Residential consumers (ResC) providing personalized tips to reduce energy bills;

b. Commercial users (ComU), providing tailored analytics to support operational efficiency, and guidance.

2.4.6.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan uses a user-friendly interface to deliver energy insights and tips, supported by newsletters that provide regular updates on pilot progress and new features. Broad outreach campaigns through social media and digital ads help increase visibility and drive consistent engagement across all stakeholder groups.

Table 13: Demo #6 (Cyprus) stakeholders' engagement plan

Activity	Target stakeholder	Description
User interface with energy tips	All	Primary digital channel for engagement, enabling access to energy insights
Newsletters	All	Periodic updates on pilot progress, new app features, and energy insights.
Campaigns	All	Outreach through social media, Google ads, and energy-related newsletters.

2.4.6.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To address low engagement, the strategy includes interactive features, progress tracking, and visual success stories. Commercial users are targeted with ROI-focused messaging and simple savings examples. Transparency and strict data privacy practices build trust, while alternative formats like phone support and in-person sessions ensure accessibility for users with low digital literacy.

Table 14: Demo #6 (Cyprus) risk considerations and mitigation measures

Risk	Mitigation measure
Low engagement	Include interactive content, progress tracking, and visual success stories
Commercial users overlook the platform	Provide ROI-related messages and simple examples of savings
Uncertainty about data use	Transparent communication and strict data privacy compliance
Low digital literacy	Provide alternative formats (e.g., call support, in-person briefings).

2.4.7. DEMO #7 (GREECE)

Pilot Leader: MYTILINEOS (METLEN) / HEDNO

Supporting Partner: ETRA

2.4.7.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Greek Demo #7 targets 2 main stakeholder groups:

a. Residential consumers (ResC) facilitating access to consolidated energy data and tips to reduce energy bills;

b. Local Authorities, NGOs, Tech Partners, bringing visibility regarding trends and user interaction and bringing lessons for scaling community-wide energy engagement.

2.4.7.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement strategy includes targeted email and phone outreach to onboard residential consumers, supported by interactive online workshops that engage stakeholders in feedback and co-creation. Social media updates enhance visibility and build community interest across all groups involved in the pilot.

Table 15: Demo #7 (Greece) stakeholders' engagement plan

Activity	Target stakeholder	Description
Email and phone outreach	ResC	Engagement to inform and onboard selected users

Online workshops	Local Authorities, NGOs, Tech Partners	Interactive sessions to explain demo goals, gather feedback, and co-create
Social Media	All	Updates to increase visibility and community interest

2.4.7.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To address outdated infrastructure, the plan includes pre-validation and proactive replacement of legacy equipment. Low interest in monitoring tools is countered by emphasizing user benefits such as cost savings and environmental impact. For users with limited digital skills, support is provided through alternative formats like phone assistance and in-person guidance.

Table 16: Demo #7 (Greece) risk considerations and mitigation measures

Risk	Mitigation measure

Outdated or malfunctioning infrastructure	Pre-validation and proactive replacement of legacy equipment
Low user interest in monitoring tools	Highlight user benefits (e.g., cost awareness, environmental impact).
Low digital literacy	Provide alternative formats (e.g., call support, in-person briefings).

2.4.8. DEMO #8 (SWEDEN)

Pilot Leader: Checkwatt

2.4.8.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Swedish Demo #8 targets 2 main stakeholder groups:

a. Residential consumers (ResC) providing improved awareness of site energy performance;

b. Installation partners, Increased demand for integrated PV, battery systems, business validation of value-added energy services

2.4.8.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan includes social media campaigns to highlight platform features and value for residential consumers, supported by newsletters and questionnaires for ongoing feedback and app co-development. Installation partners are engaged through focus groups and physical meetings to discuss business integration and gather practical insights.

Table 17: Demo #8 (Sweden) stakeholders' engagement plan

Activity	Target stakeholder	Description
Social Media outreach	ResC	Campaigns promote platform features flex. value.
Email newsletters & questionnaires	ResC	Periodic updates and feedback mechanisms to co-develop app improvements
Physical meetings / Focus Groups	Installation Partners	In-person sessions to explore business integration and gather insights.

2.4.8.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To encourage engagement with new platform features, the plan includes financial incentives, clear visuals, and targeted campaigns. Technical glitches are managed by limiting initial rollout to selected users and conducting close monitoring. Limited partners buy-in is addressed through co-creation focus groups to ensure features align with installer needs and expectations.

Table 18: Demo #8 (Sweden) risk considerations and mitigation measures

Risk	Mitigation measure
Low engagement with new platform features	Use financial incentives, clear visuals, and targeted campaigns
Technical glitches during live testing	Limit early rollout to selected users and monitor closely
Limited partners buy-in	Use co-creation focus groups to align features with installer interests

2.4.9. DEMO #9 (PORTUGAL)

Pilot Leaders: E-REDES & RD-NESTER

2.4.9.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Portuguese Demo #9 targets 2 main stakeholder groups:

a. Residential consumers (ResC) to access digital tools for energy visibility and flexibility services.

b. DSO & TSO operators to validate interoperability protocol and coordination flow, and experience with integrated consumer engagement in flexibility schemes

2.4.9.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan reconnects with existing residential consumers to streamline onboarding and participation. Onsite presentations explain the pilot's goals, while participation contracts formalize roles and consent. In-app messaging keeps users informed and promotes real-time engagement throughout the demonstration period.

Table 19: Demo #9 (Portugal) stakeholders' engagement plan

Activity	Target stakeholder	Description

Outreach to existing customers	ResC	Reconnect with previously engaged customers for fast-track participation
Onsite presentations	ResC	Communicate demo objectives and onboarding details
Pilot participation contracts	All	Formalize responsibilities consent
In-app communication	ResC	Provide updates and encourage real-time interaction with the pilot

2.4.9.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To re-engage past customers, the plan includes personalized outreach and a simplified re-enrolment process. Technical coordination challenges between DSO and TSO are addressed through early testing and close collaboration. Low app interaction is mitigated by integrating familiar platforms and emphasizing features that deliver added value to users.

Table 20: Demo #9 (Portugal) risk considerations and mitigation measures

Risk	Mitigation measure

Low customer from past projects	Personalized outreach and simplified re-enrolment process
Technical challenges in DSO-TSO coordination	Early testing and close collaboration
App low interaction	Use of familiar platforms with added value features

2.4.10. DEMO #10 (CROATIA)

Pilot Leader: HOPS

2.4.10.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Croatian Demo #10 targets 1 stakeholder group:

a. Residential consumers (ResC) valorise transparent access to consumption data and energy insights.

2.4.10.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan involves direct outreach to residential consumers for recruitment, supported by informational sessions to explain pilot goals and participation terms. Consent collection ensures regulatory compliance, while DSO coordination workshops facilitate joint planning for data access and system integration across all stakeholders.

Table 21: Demo #10 (Croatia) stakeholders' engagement plan

Activity	Target stakeholder	Description
Direct consumer contact	ResC	Targeted outreach for pilot recruitment
Information presentations	ResC	Public or closed sessions to explain objectives and participation terms
Consent collection process	ResC	Ensuring compliance with privacy and regulatory aspects
DSO coordination workshops	ResC	Collaborative planning on data access and backend integration

2.4.10.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To address recruitment challenges, the plan includes early outreach and simplified onboarding. Data exchange delays with the DSO are mitigated through formal cooperation agreements established in advance. Ensuring the app meets user expectations is achieved through iterative testing and continuous updates informed by user feedback.

Table 22: Demo #10 (Croatia) risk considerations and mitigation measures

Risk	Mitigation measure
Difficulty in recruiting participants	Early and simplifying onboarding processes
Data exchange delays with DSO	Pre-alignment through formal cooperation agreements
App not aligned with user expectations	Iterative testing and updates based on feedback

2.4.11. DEMO #11 (CZECH REPUBLIC)

Pilot Leader: CEZ Distribuce

2.4.11.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

The Czech Demo #11 targets 1 stakeholder group:

a. Residential consumers (ResC) with a more intuitive, valuable experience from the utility's digital platform valorise transparent access to consumption data and energy insights.

2.4.11.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan secures informed participation from residential consumers through transparent consent collection. App testing involves all users, gathering valuable feedback to improve functionality. Internally, consolidated feedback is reviewed and shared to guide future service enhancements and engagement strategies.

Table 23: Demo #11 (Czech Republic) stakeholders' engagement plan

Activity	Target stakeholder	Description
Consent collection	ResC	Informed participation secured though transparent data use terms
App testing	ResC	Pilot users provide feedback through testing
Summary of feedback & sharing	ResC	Consolidated results inform future service design and engagement strategy

2.4.11.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To boost app feedback, the plan includes clear instructions and incentives to encourage user participation. To distinguish the pilot from existing apps, onboarding highlights new features and added benefits. Data privacy concerns are addressed through robust communication and GDPR-compliant consent processes to ensure user trust and transparency.

Table 24: Demo #11 (Czech Republic) risk considerations and mitigation measures

Risk	Mitigation measure
Low app feedback from users	Use clear instructions and incentives for participation
Insufficient differentiation from existing app	Highlight new benefits and enhancements during onboarding
Data privacy concerns	Ensure robust communication and GDPR-aligned consent procedures

2.4.12. DEMO #12 (POLAND)

Pilot Leader: TAURON Dystrybucia S.A.

2.4.12.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

a. Residential consumers (ResC) monitor different tariffs; pro-ecological activities access to an improved utility app supporting transparency and engagement.

b. RES prosumers (RESp) with energy monitoring regarding different tariffs; pro-ecological activities, reduction of power exceeds.

c. Energy cluster & cooperative with energy monitoring regarding different tariffs, pro-ecological activities, reduction of power exceeds.

2.4.12.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan involves targeted outreach to select residential consumers aligned with pilot goals. Presentations explain the demonstration's objectives and participation steps. Consent and onboarding ensure informed and compliant involvement, while real-world app interaction and testing provide valuable feedback and usage data to refine the solution.

Table 25: Demo #12 (Poland) stakeholders' engagement plan

Activity	Target stakeholder	Description
Targeted Outreach	ResC	User selection based on relevance to pilot objectives
Consumer presentations	All	Explaining demo goals and participation process
Consent & onboarding	All	Ensuring informed and compliant user participation
App interaction & testing	All	Collecting feedback and usage data during real-world testing

2.4.12.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To address user confusion over app updates, the plan provides step-by-step tutorials and integrated help features. Low consumer engagement is mitigated through clear incentives and communication focused on user needs. Challenges in TSO-DSO alignment are handled through early technical coordination and a modular system design that allows flexible integration.

Table 26: Demo #12 (Poland) risk considerations and mitigation measures

Risk	Mitigation measure
App changes unclear to users	Step-by-step tutorials and in-app help
Low engagement from consumers	Use of clear incentives and user-centred communication
Difficulty aligning TSO-DSO	Early technical coordination and modular design

2.4.13. DEMO #13 (ROMANIA)

Pilot Leader: NUSTPB

2.4.13.1. STAKEHOLDER IDENTIFICATION AND VALUE PROPOSITION

a Consumers (Residential and Didactic Users): energy insights, energy efficiency awareness, environmental awareness, reduce emissions and footprint.

2.4.13.2. STAKEHOLDERS' ENGAGEMENT PLAN

The engagement plan involves targeted advertising to raise awareness among residential and didactic users, supported by physical meetings for direct interaction and focus groups to gather insights and encourage co-creation. These activities aim to communicate project benefits, foster energy awareness, and ensure users are actively involved in shaping and adopting the solution.

Table 27: Demo #13 (Romania) stakeholders' engagement plan

Activity	Target stakeholder	Description
Targeted advertising	Residential and Didactic Users	Promote awareness of the project's benefits using tailored digital content
Physical meetings	Residential and Didactic Users	Host in-person sessions to explain objectives and collect feedback
Focus groups	Residential and Didactic Users	Facilitate discussions to explore needs and co-design improvements

2.4.13.3. RISK CONSIDERATIONS AND MITIGATION MEASURES

To address low participation and limited energy awareness among residential and didactic users, the plan combines targeted outreach with clear communication of benefits and incentives. Educational materials and live demonstrations help build understanding and motivation. To alleviate privacy concerns, the strategy includes transparent data practices and

GDPR-compliant consent processes to build trust and ensure informed user involvement.

Table 28: Demo #13 (Romania) risk considerations and mitigation measures

Risk	Mitigation measure
Low participation from users	Use targeted outreach, highlight benefits clearly, and offer incentives
Limited energy awareness	Provide educational materials and hands-on demonstrations during meetings
Privacy concerns	Ensure GDPR-compliant consent processes and transparent data communication

2.4.14. CONCLUSIONS AND HORIZONTAL ENGAGEMENT STRATEGIES

The ECLIPSE pilots offer a comprehensive view of how digital tools, stakeholder strategies, and regulatory alignment can converge to empower consumers in the evolving energy landscape. A central approach from all pilots is that meaningful engagement is not one-size-fits-all, but it requires localized, user-focused solutions that combine digital innovation with trust, relevance, and ease-of-use.

Digital interfaces, particularly mobile apps and online portals emerge as the primary channel for consumer interaction. Whether by enhancing existing platforms or building new ones in alignment with CERF, partners prioritize features that support real-time feedback, tailored energy insights, and simple participation in demand-response schemes. These tools serve both as technical enablers, and as essential bridges between consumers and the grid.

Of high importance is also the backend infrastructure supporting these front-end tools. The pilots demonstrate the value of robust data interoperability, especially between DSOs and TSOs. The use of APIs, analytics engines, and secure data flows ensure reliable integration while enabling more dynamic and informed participation by users.

On the human side, engagement approaches showcase the diversity of the participating regions and indicate common success factors. Effective strategies combined awareness-building campaigns with co-creation activities, personalized messaging, and ongoing feedback collection. Social media, workshops, and targeted communications are used to inform and activate users throughout the pilot lifecycle.

From these varied answers from the questionnaires, a **horizontal engagement model** can be designed, an adaptable strategy framework that can be scaled across different European contexts. It includes:

- Digital-first interaction, using intuitive apps and real-time communications;
- Personalized engagement, tailored to economic (e.g., pricing signals) and non-economic (e.g., environmental impact) motivations;

- Community-driven outreach, engaging energy communities, prosumers, and local actors;
- Iterative design, where user input directly forms functionality and messaging;
- Data transparency and trust, complying with GDPR practices and clear consent mechanisms;
- Continuous education, providing users with guidance, motivation, and actionable knowledge.

These elements form the backbone of the pan-European engagement strategy that is both flexible and user-centric, enhancing the effectiveness of ECLIPSE, while providing a replicable model for future digital energy initiatives.

3. DEVELOPMENT OF ECLIPSE CERF FOR ENERGY SAVING APPLICATIONS V1

3.1. INTRODUCTION

This section presents the current status of the development of the ECLIPSE CERF in the different pilots (Section 3.4), including their overall plan and the description of the specific components currently being developed and/or integrated in each of them.

Additionally, the definition of horizontal components to be used within and beyond the project to facilitate the integration of the ECLIPSE CERF is provided. These components include the APIs for a subset of the identified interfaces in the CERF architecture (Section 3.2), an ECLIPSE end user application (Section 3.3), and the horizontal energy services identified so far that will be used in more than one pilot (Section 3.4.14).

3.2. API INTERFACES

The components of the architecture of the ECLIPSE CERF and the interfaces among them are defined in WP3. By the time of submission of this deliverable, this definition is at an advanced stage but has still not been finished.

The definition of the APIs presented in this section is based on the current outcomes of WP3, but it will be revised and refined once the final version is presented in D3.1 “CERF architecture specification and ECLIPSE interoperability profiles”, due M15. Any changes related to these APIs will be presented in D4.2 “ECLIPSE CERF for Energy Saving applications_V2” by the end of the project.

3.2.1. CERF ARCHITECTURE AND INTERFACES

Figure 6 shows the component layer of the CERF architecture and the interfaces among them. It has been developed in T3.2 in collaboration with all ECLIPSE pilots. The relevant APIs in the CERF ecosystem that have initially been identified are highlighted in red.

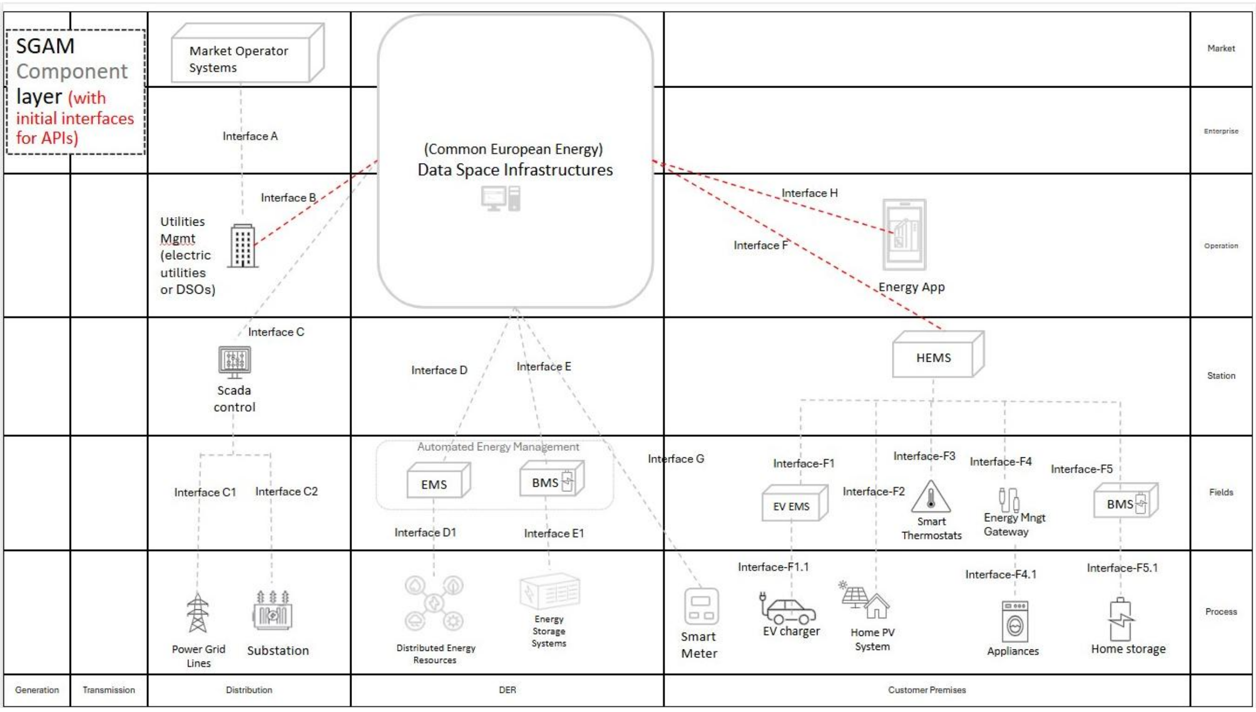


Figure 6: ECLIPSE CERF architecture and interfaces (current version, M12)

Although the complete details of the architecture will be included in D3.1 (due M15), a brief description of the main components involved in the API definition will be provided for context.

The central component of the ECLIPSE CERF architecture is the Common European Energy Data Space infrastructure. It involves the data management system(s) that collect the field data from the different levels of the energy value chain, from the status of the structural MV grid elements, to distributed energy resources, metering data, and additional home appliances and devices.

In some cases, the Data Space Infrastructures will be instantiated by an actual Data Space that manages the access to the data from the different systems, while in others, the original data sources from each one will be directly integrated instead.

The interfaces connected to the Data Space Infrastructures interact with the main actors from the energy ecosystem, namely:

- Utilities and DSOs (interfaces B and C),
- Energy producers and service providers (interfaces D and E), and
- End customers (interfaces G, F, and H).

As the integration of some of these systems is typically standardized and well defined (e.g. Smart Meters, SCADA), the selection of interfaces for API implementation has been driven by their potential in providing services to the end user and fulfilling the use cases of the project. With this in mind, the selected interfaces APIs are defined for are:

- The DSO/utilities interface (B),
- The HEMS interface (F),
- The Energy app interface (H).

The description of these APIs is provided in subsequent sections. However, as the architecture is not finalised and modifications to CERF interfaces are possible in the future—in particular with the integration of Data Spaces—these descriptions will be updated in the second version of this deliverable.

3.2.2. API INTERFACES IMPLEMENTATION

The implementation of the ECLIPSE CERF API interfaces is not built from scratch but takes the Interoperable DSO Interface (DSOi) [26] from InterConnect project [1] as a starting point.

The DSOi defines a set of services that connect the DSO and external agents (namely Flexibility Aggregators). It relies on the InterConnect architecture and ecosystem of modules that were previously presented in Section 2.2.1 InterConnect Generic Adapter (GA), including the GA itself. Thus, it was considered a fitting choice for this part of the ECLIPSE CERF implementation.

The technical specification of the DSOi is described in D4.2 of InterConnect [27]. The APIs for the ECLIPSE CERF interfaces are presented below. They are currently under development and will be validated and tested during the second period of the project.

3.2.2.1. DSO/UTILITIES API (INTERFACE B)

Interface B represents the link between the Common European Energy Data Space infrastructure and Utilities Management (electric utilities or DSO). It covers onboarding, grid-zone information, metering data and flexibility transactions.

The main API calls are listed in Table 29 and are re-used from the InterConnect DSOi. Additional endpoints to complement its functionalities are shown in Table 30.

Table 29: DSO interface endpoints (from InterConnect DSOi)

Path	Method	Description
/Generic/Registration	**POST**	Register new external entity (API key, name, vat ID, phone, email, access type)
/Generic/Registration	**PATCH**	Update registration information entity (API key, name, vat ID, phone, email, access type)
/Generic/gridZones	**GET**	Retrieve available grid zones and details (API key, country)
/Generic/gridZones/{meterId}	**GET**	Retrieve meter ID grid zone (API key, meter ID)
/Data/Metering	**GET**	Retrieve historical metering data entity (API key, type of data [user, aggregated], zone or user ID, granularity [15m, 1h, 1d], start time, end time)
/Data/FlexibilityNeeds	**GET**	Retrieve historical or forecasted flexibility needs (API key, zone ID, start time, end time)
/Flexibility/Subscribe	**POST**	Subscribe to needs and activation plan webhook (API key, flexibility needs callback URL, activation plan callback URL)
/Flexibility/Subscribe	**DELETE**	Unsubscribe from needs and activation plan webhook (API key)
/Flexibility/Offers	**POST**	Submit flexibility offers to the DSO (API key, flexibility offer)

/Flexibility/Baseline	**POST**	Submit baseline to the DSO (API key, flexibility baseline)

Table 30: Utilities interface additional endpoints

Path	Method	Description
/Data/Authorization	**GET**	Validate data-access authorization (API key, data access authorization ID, authorization result)
/Flexibility/Needs	**POST**	Publish flexibility needs to service-provider (API key, flexibility request)
/Flexibility/ActivationPlan	**POST**	Send flexibility activation plan to service-provider (API key, flexibility activation plan)

3.2.2.2. HEMS API (INTERFACE F)

Interface F represents the link between the Common European Energy Data Space infrastructure and Home Energy Management Systems (HEMS). These APIs let each HEMS register, submit device measurements and, when subscribed, receive set-point commands. All relevant endpoints are listed in Table 31.

Table 31: HEMS interface endpoints

Path	Method	Description
/Device/Registration	**POST**	Register a device (API key, supply point id, name, model, description, type, nominal power)
/Device/Registration	**PATCH**	Update device data (API key, device id, name, description, nominal power)
/Device/Registration	**DELETE**	Delete device (API key, device id)
/Data/Measurements	**POST**	Send measurements from devices (API key, array of: [device id, measurement type, timestamp, value, unit])
/Setpoints/Subscribe	**POST**	Subscribe to set points (commands) to a specific device (API key, device id, endpoint)
/Setpoints/Subscribe	**DELETE**	Unsubscribe from set points (commands) to a specific device (API key, device id)

3.2.2.3. ENERGY APP API (INTERFACE H)

Interface H represents the link between the Common European Energy Data Space infrastructure and Energy Applications. Through these APIs, an app can manage users, access supply-point and tariff data, and subscribe to notifications or personalised tips. All relevant endpoints are listed in Table 32.

Table 32: Energy app interface endpoints

Path	Method	Description
/User/Register	**POST**	Register user (username, email, ID num, password)
/User/GetData	**GET**	Get user data (API key)
/User/UpdatePassword	**POST**	Update password (API key, new password)
/User/UpdateBankDetails	**POST**	Update bank details (API key, iban)
/SupplyPoint/Register	**POST**	Register usage point (API key, name, location, usage point number)
/SupplyPoint/GetData	**GET**	Get supply point data (API key, supply point id)
/SupplyPoint/AddAppliance	**POST**	Add appliance (API key, supply point id, name, model, description, type, nominal power)
/SupplyPoint/GetMeasurements	**GET**	Query hourly active imported and exported energy, min/max/avg active power measurements (API key, supply point id, start date, end date)
/SupplyPoint/SetThreshold	**POST**	Set consumption threshold (API key, supply point id, type=[D,W,M], value (kWh))
/SupplyPoint/GetThresholds	**GET**	Get consumptions thresholds (API key, supply point)

/SupplyPoint/ModifyInstalledPower	**POST**	Modify installed power (API key, supply point, tariff id, installed power values)
/EnergyPrice/GetData	**GET**	Query (quarter-)hourly energy price data (API key, supply point id, start date, end date)
/Reports/SendReport	**POST**	Send report (API key, category, report details)
/Reports/SentReports	**GET**	Get sent reports (API key, category (optional), status (optional), start date (optional), end date (optional))
/GeneralTips/Subscribe	**POST**	Subscribe to general tips (API key, endpoint)
/GeneralTips/Subscribe	**DELETE**	Unsubscribe from general tips (API key)
/PersonalizedTips/Subscribe	**POST**	Subscribe to personalized tips (API key, supply point id, endpoint)
/PersonalizedTips/Subscribe	**DELETE**	Unsubscribe from personalized tips (API key, supply point id)
/Notifications/Subscribe	**POST**	Subscribe to notifications (API key, supply point id, endpoint)
/Notifications/Subscribe	**DELETE**	Unsubscribe from notifications (API key, supply point id)

3.3. ECLIPSE USER APPLICATION

As part of T4.3, ETRA is developing an end-user energy application to be integrated into the CERF and demonstrated in several demo sites as part of ECLIPSE.

The purpose of the ECLIPSE user application is twofold. On the one hand, it serves as an example on how technology providers can integrate their end user applications with the ECLIPSE CERF to provide services to both their end users and the grid operators. On the other hand, it will cover the functionalities for end users in those pilots of the project where currently there is no energy application, or they do not have the capabilities to carry out their integration.

The subsequent sections describe the functionalities of the ECLIPSE user application identified after the needs of the pilots were extracted from the analysis of the use cases and requirements from WP2. Next, the first prototype of the ECLIPSE user application is presented, with screenshots of the user interface and description of its sections and functionalities. This first prototype will be completed and refined during the second year of the project, to be then tested and validated in real conditions.

3.3.1. IDENTIFIED FUNCTIONALITIES

The initial set of functionalities of the ECLIPSE user application is listed in Table 33. Its connection point with the CERF will be the Energy app API

(Interface H) described in Section 3.2.2.3 of this document. The app is expected to be tested in Demo #4 (Bulgaria), Demo #6 (Cyprus), and Demo #7 (Greece), although more pilots could be eventually considered.

Table 33: ECLIPSE user application functionalities

Functionalities	Pilots and UCs
User registration	CY, GR
Management of user preferences (notifications, etc.)	CY, GR
Registration of end user appliances and characteristics	CY, GR
Real-time consumption and production monitoring	CY, GR
Integration of various energy loads (Smart Meter, PV, HVAC, DHW...)	UC GR 1.1
Disaggregated consumption based on NILM analysis results	UC CY 1.1 UC GR 1.1
Energy cost calculation based on simulated Time-of-Use tariffs	UC GR 1.1
Real-time economic-based recommendations	UC CY 1.1 UC GR 1.1

General environmental information notifications	UC BG 3.1 UC CY 2.1 UC GR 3.2
Personalized energy efficiency tips	UC CY 5.1 UC GR 3.1 UC GR 3.2
System status and general guidance for energy consumption optimization	UC BG 4.1
Collect end user feedback about application of proposed tips	UC BG 3.1
DR notifications to mitigate critical situations in the grid	UC GR 4.1
Monitoring user response to DR campaigns	UC GR 4.1
Calculation of incentives from DR campaigns	UC GR 4.1

3.3.2. FIRST PROTOTYPES

The prototypes of the ECLIPSE user application are based on previous applications from both within and outside of the project. One of the main inputs for the design of the app has been the information collected in D2.1 Analysis of existing energy monitoring applications and services in the market and of the legal framework, where an in-depth analysis of energy applications around the EU was presented.

The ECLIPSE user application features an authentication section where the end user can log in and register, and different menus that show relevant information to the user, from consumption monitoring to flexibility options.

For the registration process, the user must provide a username, email and password for his account. In addition, an identifier of the user is needed. Figure 7 shows the login and registration forms. Figure 8 shows the message displayed after the user has been registered.

Figure 7: ECLIPSE user app – Login and registration forms

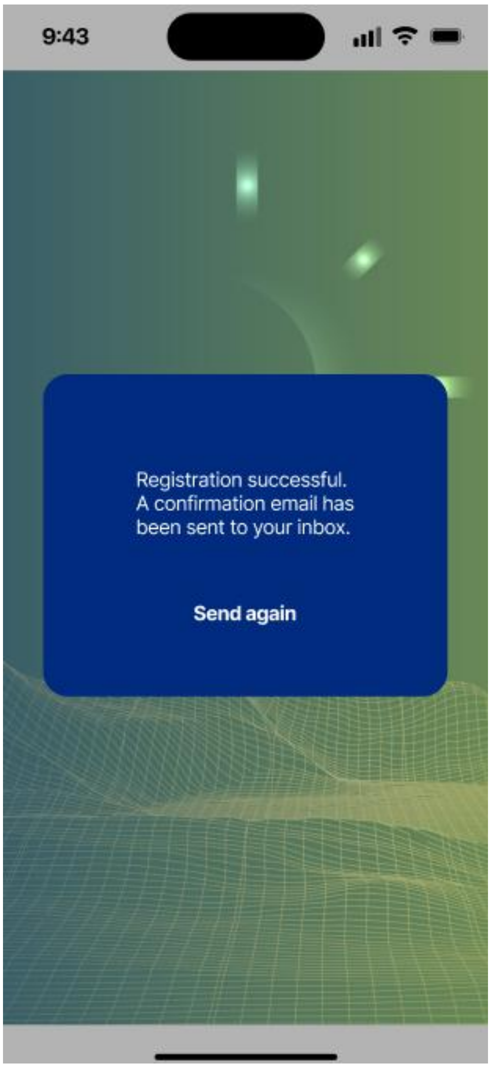


Figure 8: ECLIPSE user app – Registration message

After the registration process, the application shows the main menu, with a bar at the top and a navigation menu at the bottom. The top bar shows the name of the current section, as well as containing the notifications and the user profile buttons. On the other hand, the navigation menu at the bottom allows the user to move between the sections of the application: home, monitoring, flexibility, and tips.

Firstly, in the home screen, the user is requested to add a new supply point, from where the consumption data will be extracted. The needed information is the name the user wants to give to the supply point, the location and a unique code that identifies the supply point. Figure 9 and Figure 10 show different screenshots of the process of registration of the supply point.

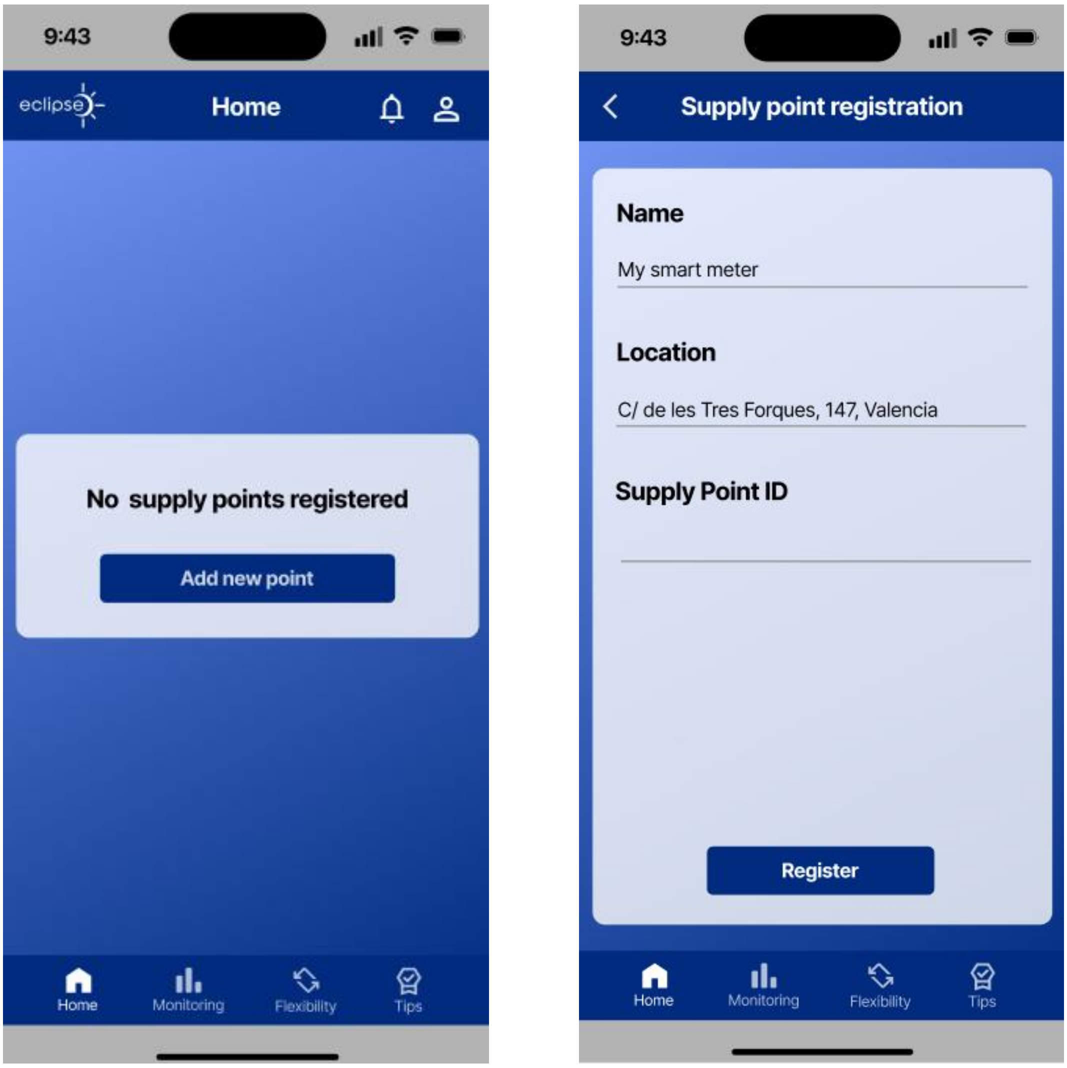


Figure 9: ECLIPSE user app – Supply point registration (1)

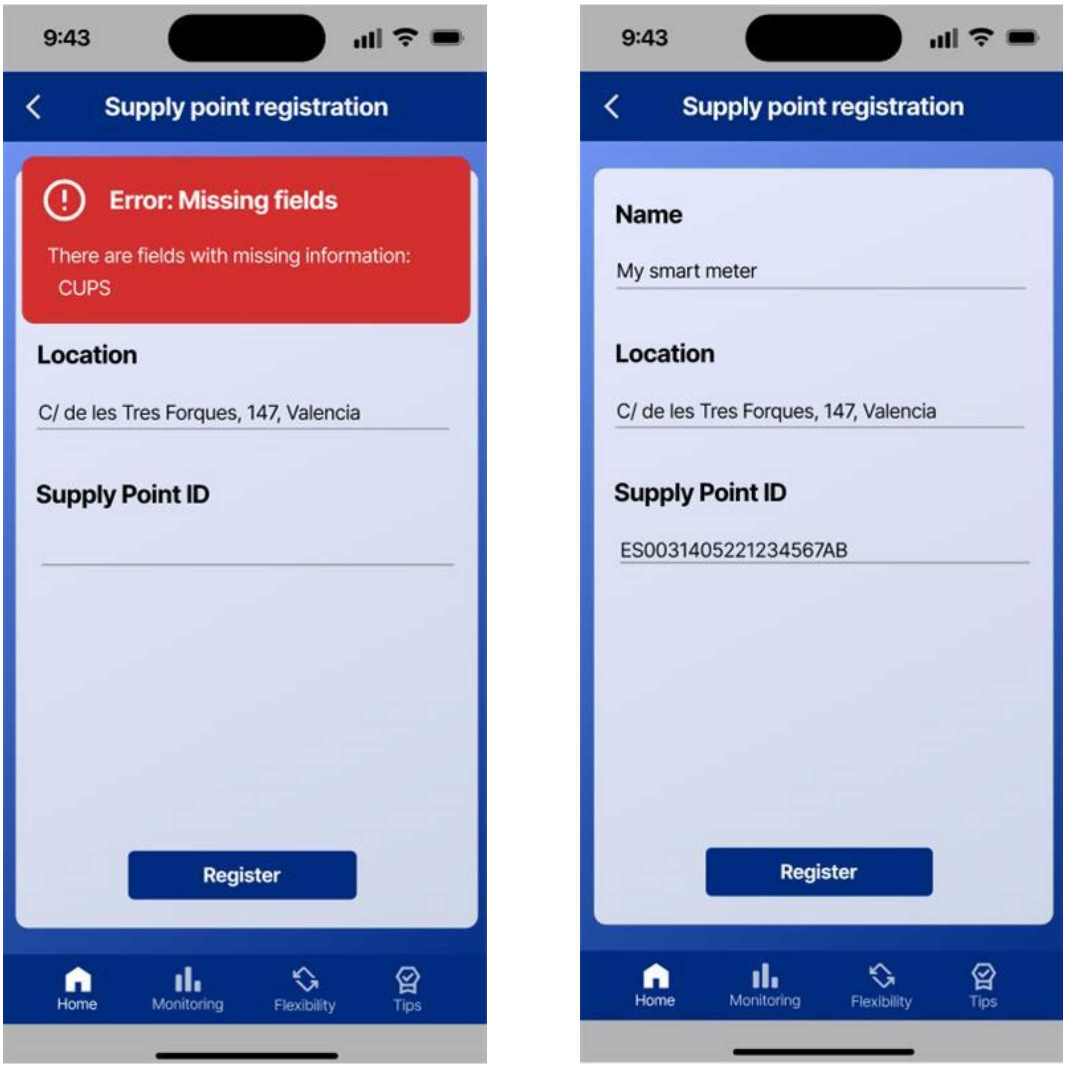


Figure 10: ECLIPSE user app – Supply point registration (2)

Once the supply point has been added, a widget is shown with their general information, together with the daily and monthly consumption. From here, the details can be edited and the user is able to add the appliances connected to the supply point (Figure 11, Figure 12, Figure 13). In addition, the previous appliances can be edited and, if a specific appliance type is not within the existing ones, it can be classified as "other" while adding its power rating for reference (Figure 14).

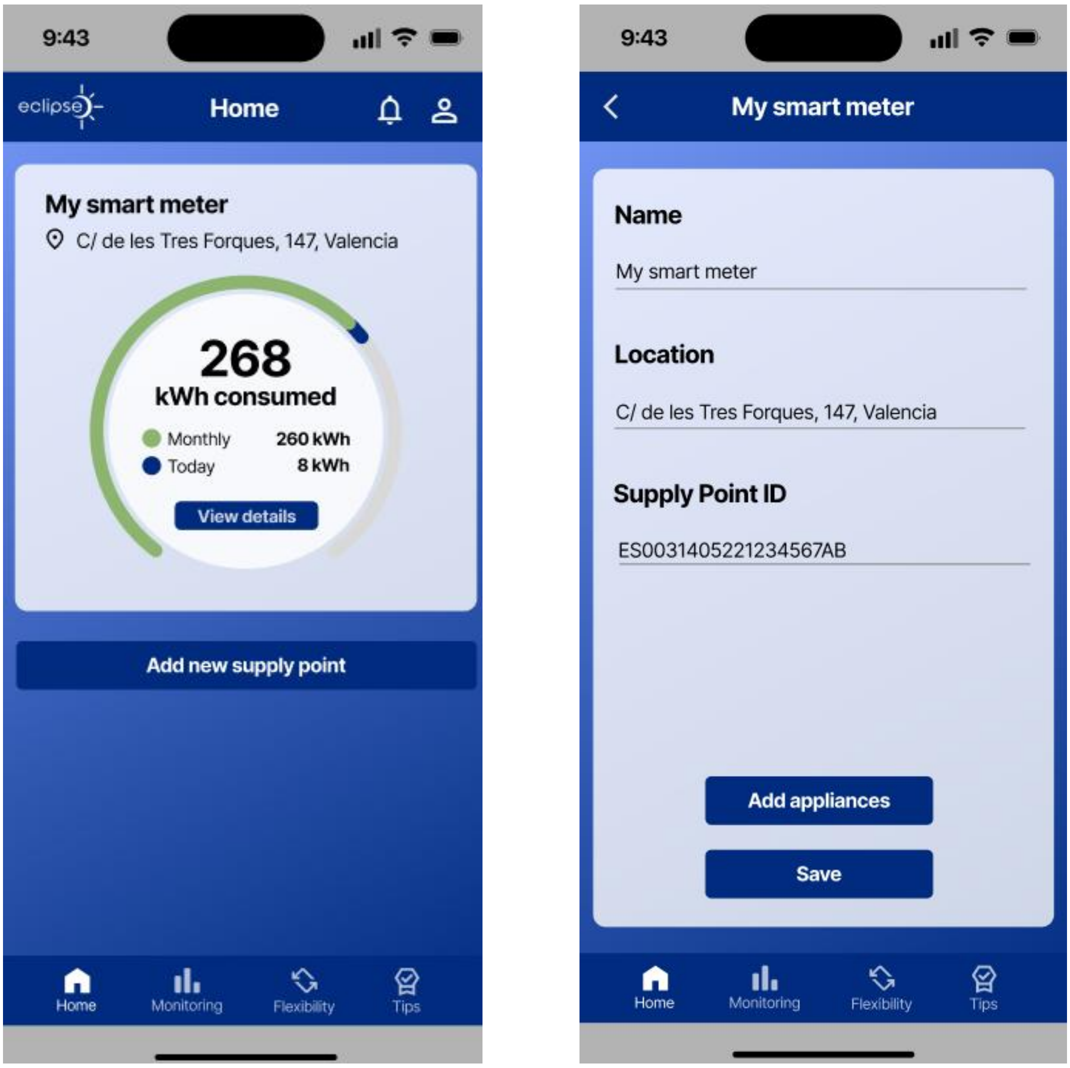


Figure 11: ECLIPSE user app – Smart meter information

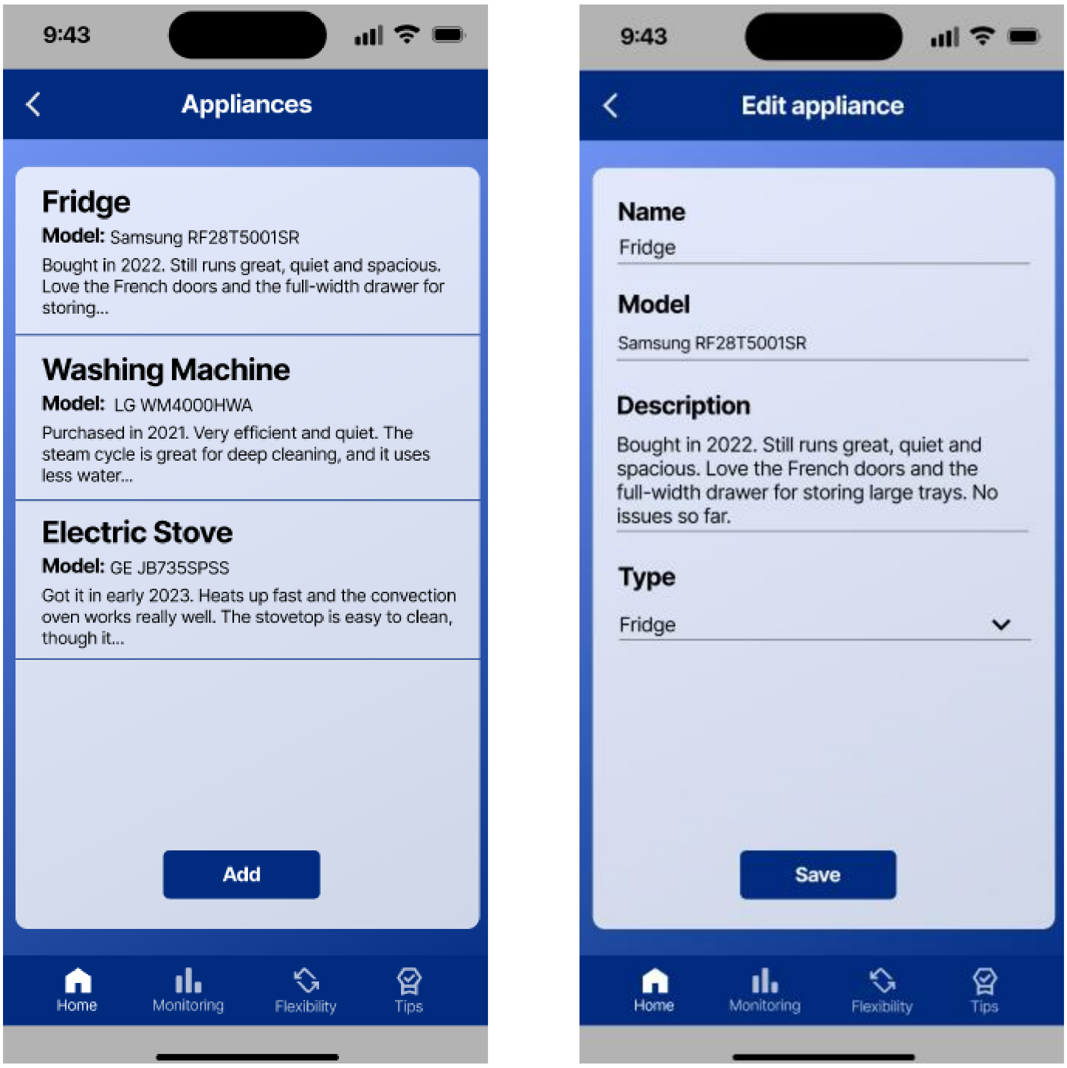


Figure 12: ECLIPSE user app – Appliances (1)

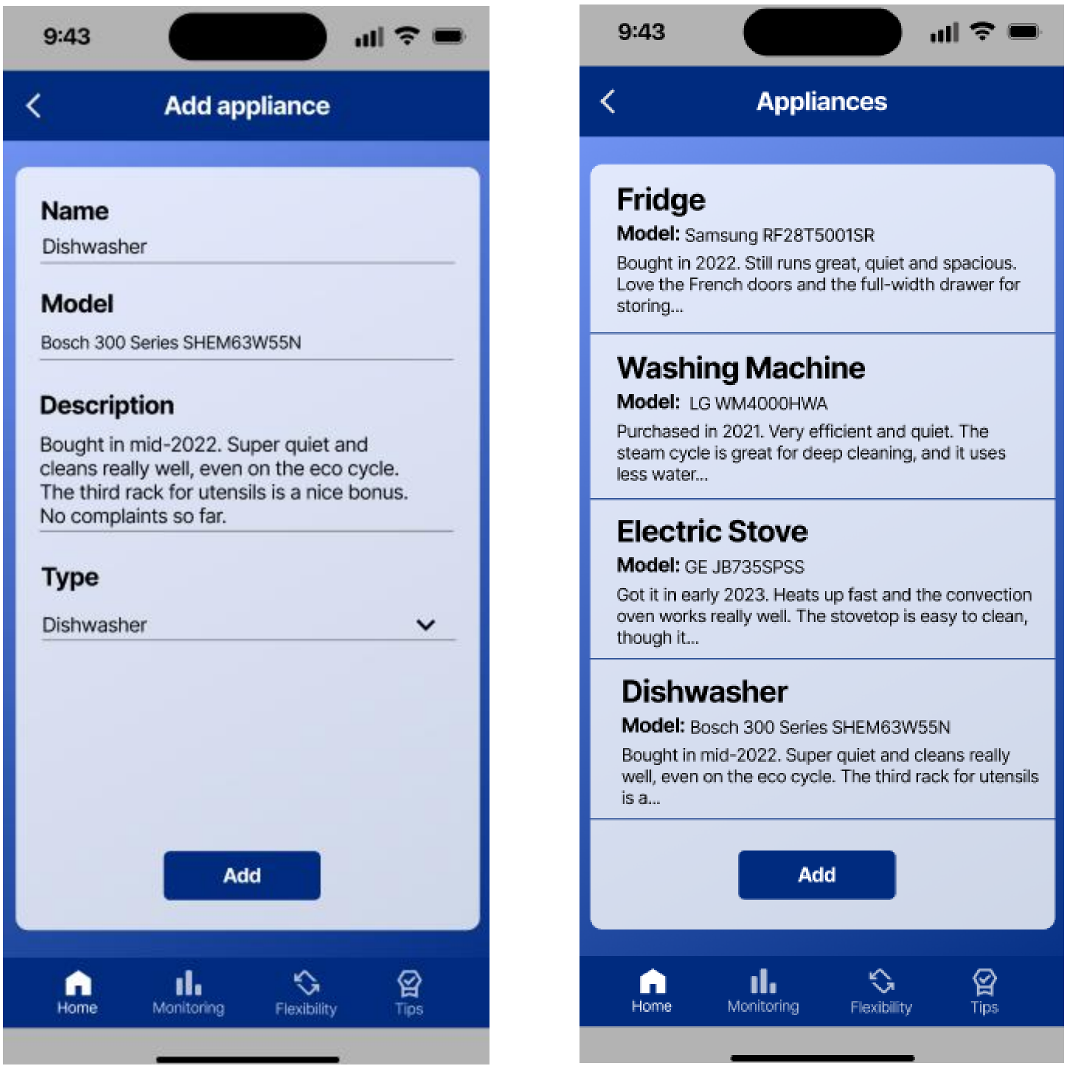


Figure 13: ECLIPSE user app – Appliances (2)

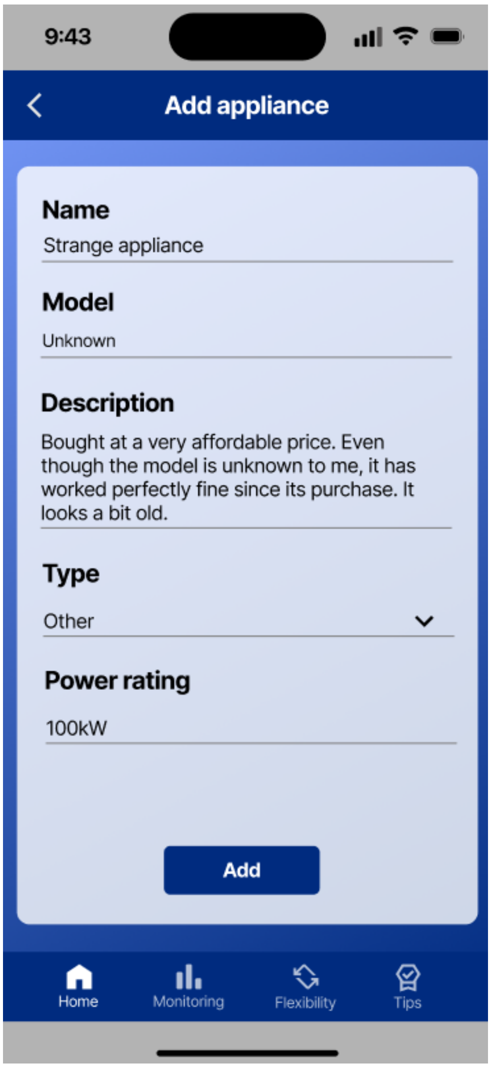


Figure 14: ECLIPSE user app – Appliances (3)

In the monitoring section, users can view information related to their energy consumption, both aggregated and disaggregated, as well as the associated economic costs (Figure 15, Figure 16). The data displayed is tailored to the user's role. For example, if the Transmission System Operator (TSO) is providing the data, information relevant to the real-time status of the transmission grid, such as system load, balancing indicators, or interconnection flows will be displayed. In contrast, users from a Distribution

System Operator (DSO) will be shown data specific to their supply points, including local consumption, load curves, and quality of supply. The specific graphs and metrics shown will depend on the available data sources, with some examples illustrated below.

Figure 15: ECLIPSE user app – Consumption monitoring

Figure 16: ECLIPSE user app – Electricity cost

In the flexibility section, actions can be taken to modify the functionalities of the application and the contracted power for their supply point(s). Reports can also be sent in case there is any issue with the grid, the power supply, etc.

Figure 17 shows how the user is able to define the thresholds that will be used by the app to notify when their consumption exceeds them.

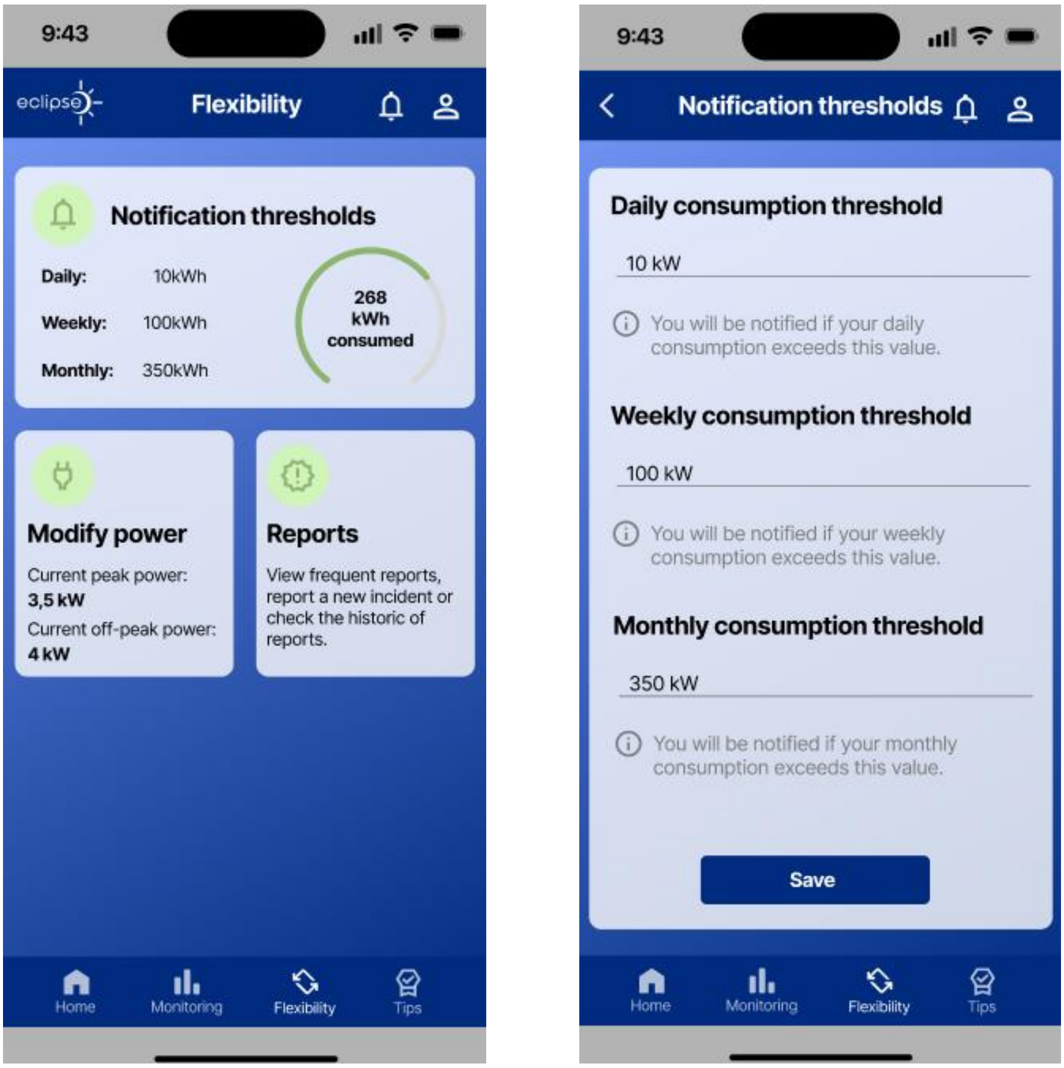


Figure 17: ECLIPSE user app – Flexibility notifications

Figure 18 show the options for the user to modify the installed power of their supply point, as well as the reporting section. The user can select the category of the report and provide the details (continued in Figure 19).

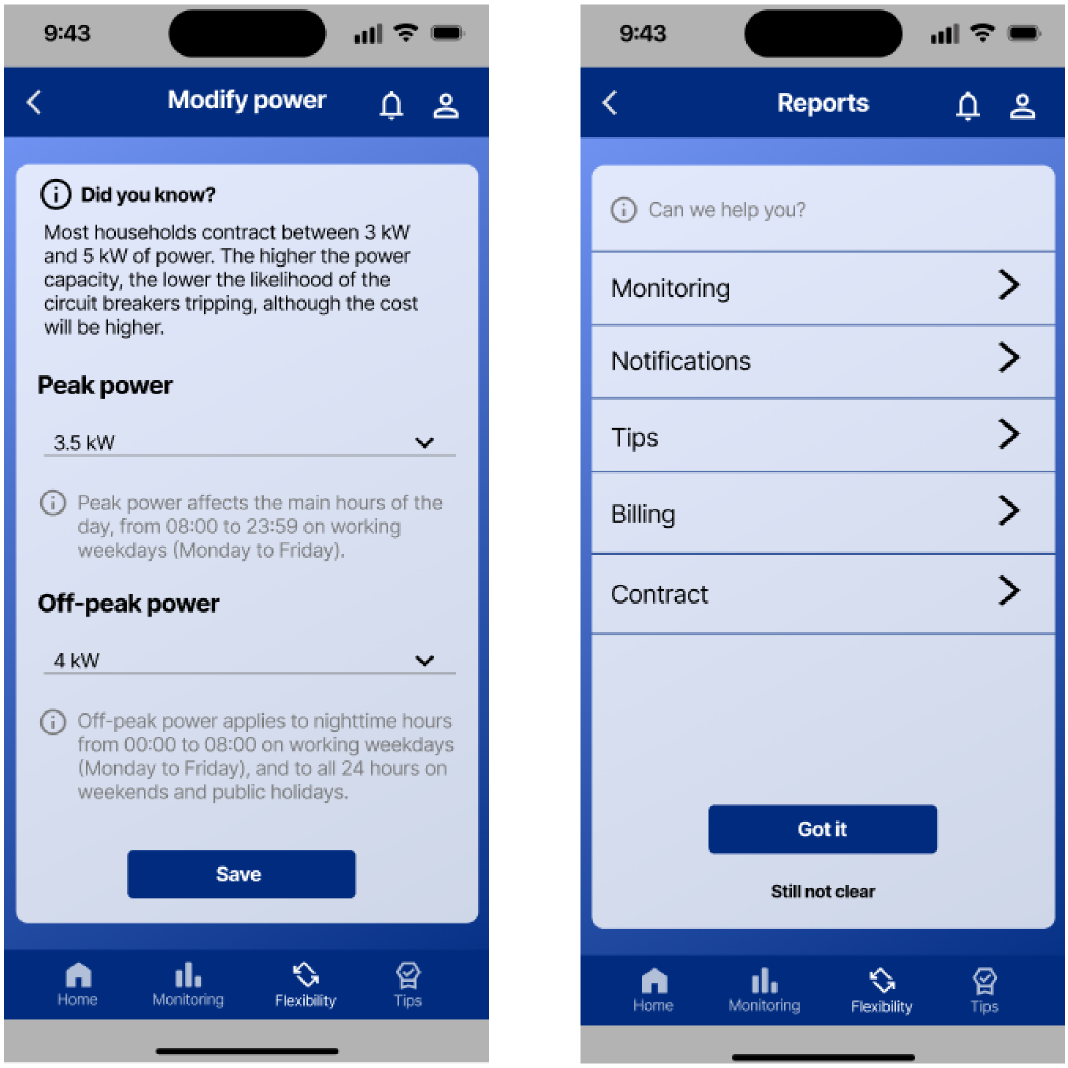


Figure 18: ECLIPSE user app – Power modification and reporting

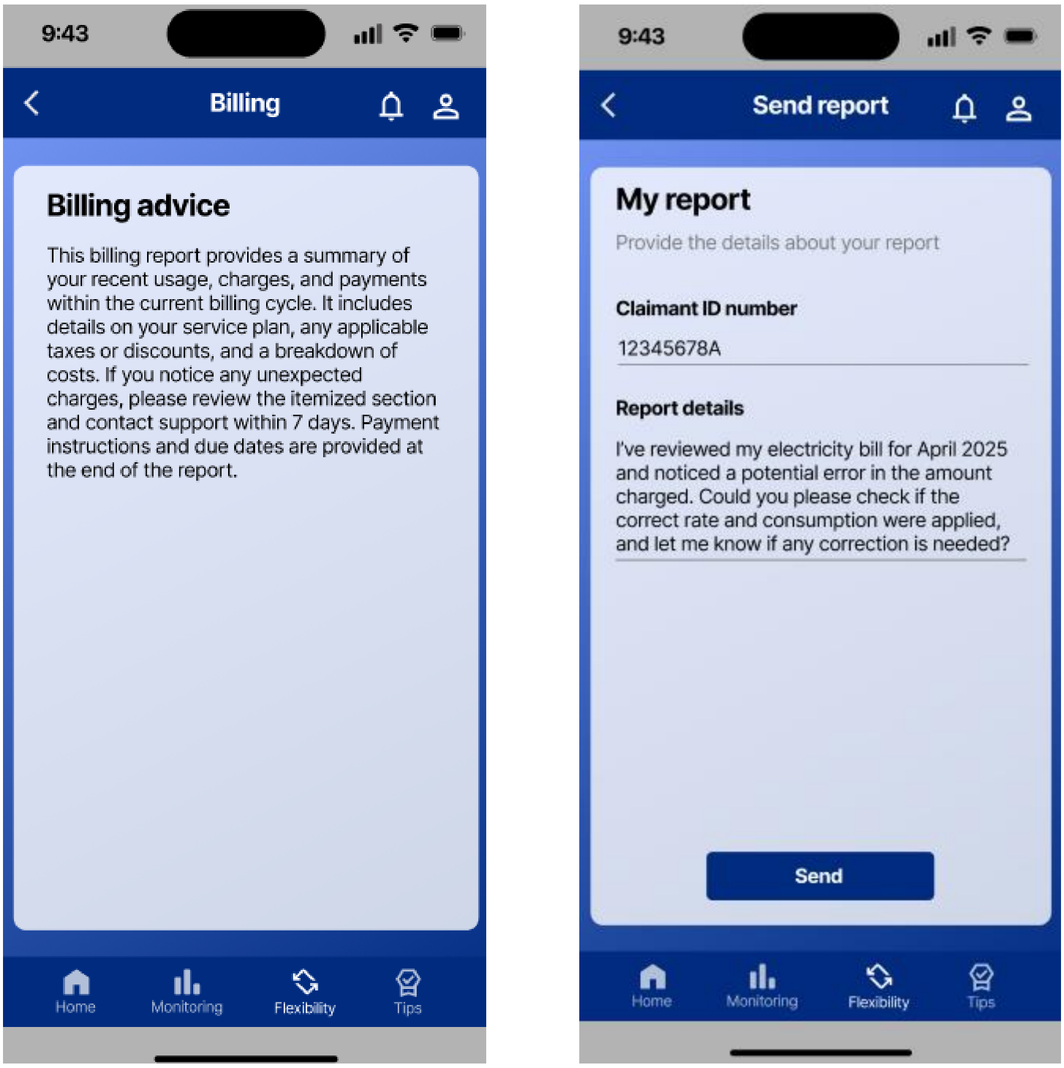


Figure 19: ECLIPSE user app – Billing advice and reporting

Then, in the tips section, both general and personalized tips on how to reduce energy consumption and costs will be shown to the user. Figure 20 and Figure 21 show examples of the categories and the types of tips to be provided to the user.

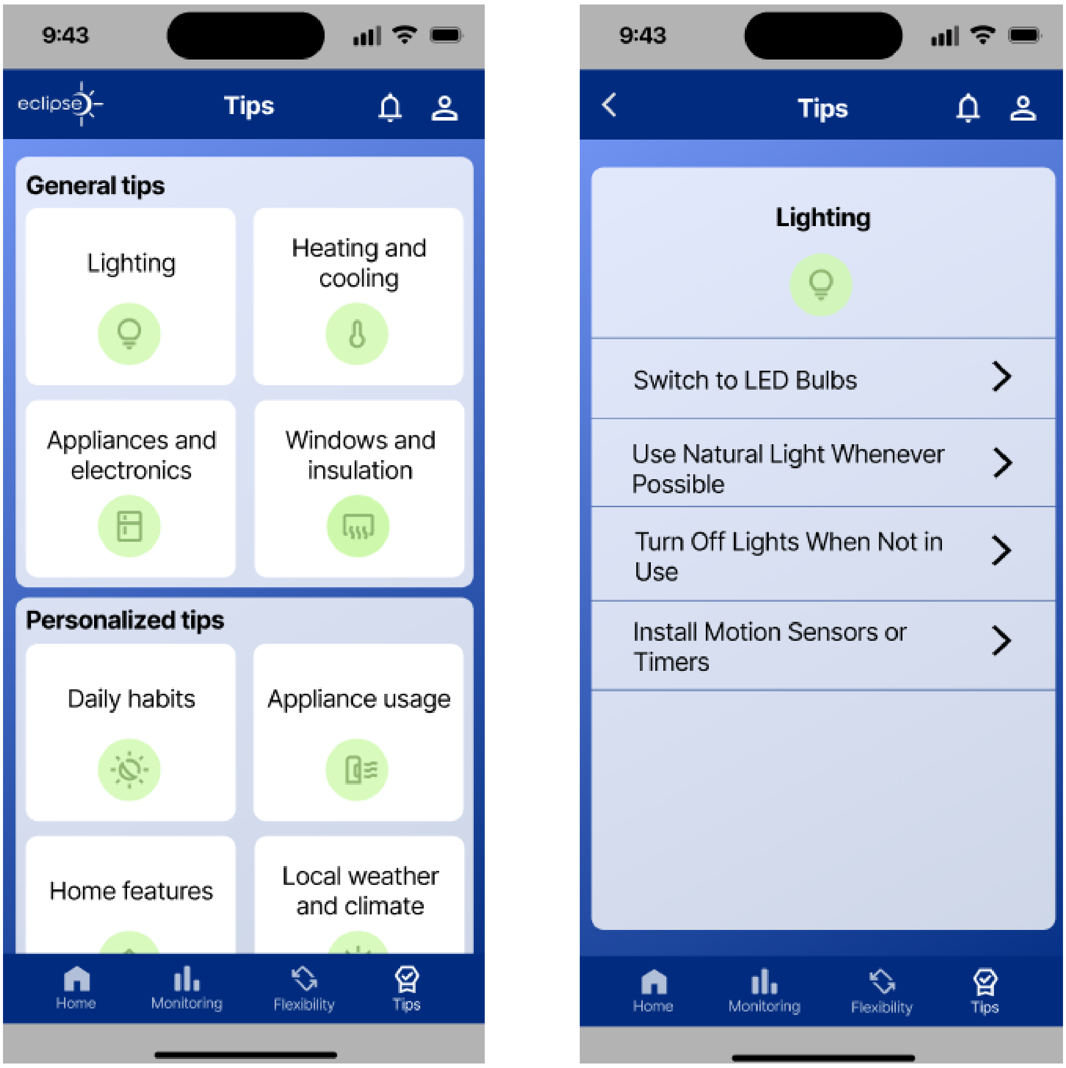


Figure 20: ECLIPSE user app – Energy optimization tips (1)

Figure 21: ECLIPSE user app – Energy optimization tips (2)

Finally, in the top menu, notifications will be displayed, ranging from consumption alerts to daily/weekly summaries, etc. Figure 22 and Figure 23 show some examples of these modifications, which will be adapted depending on the necessities of the pilot.

Figure 22: ECLIPSE user app – Notifications (1)

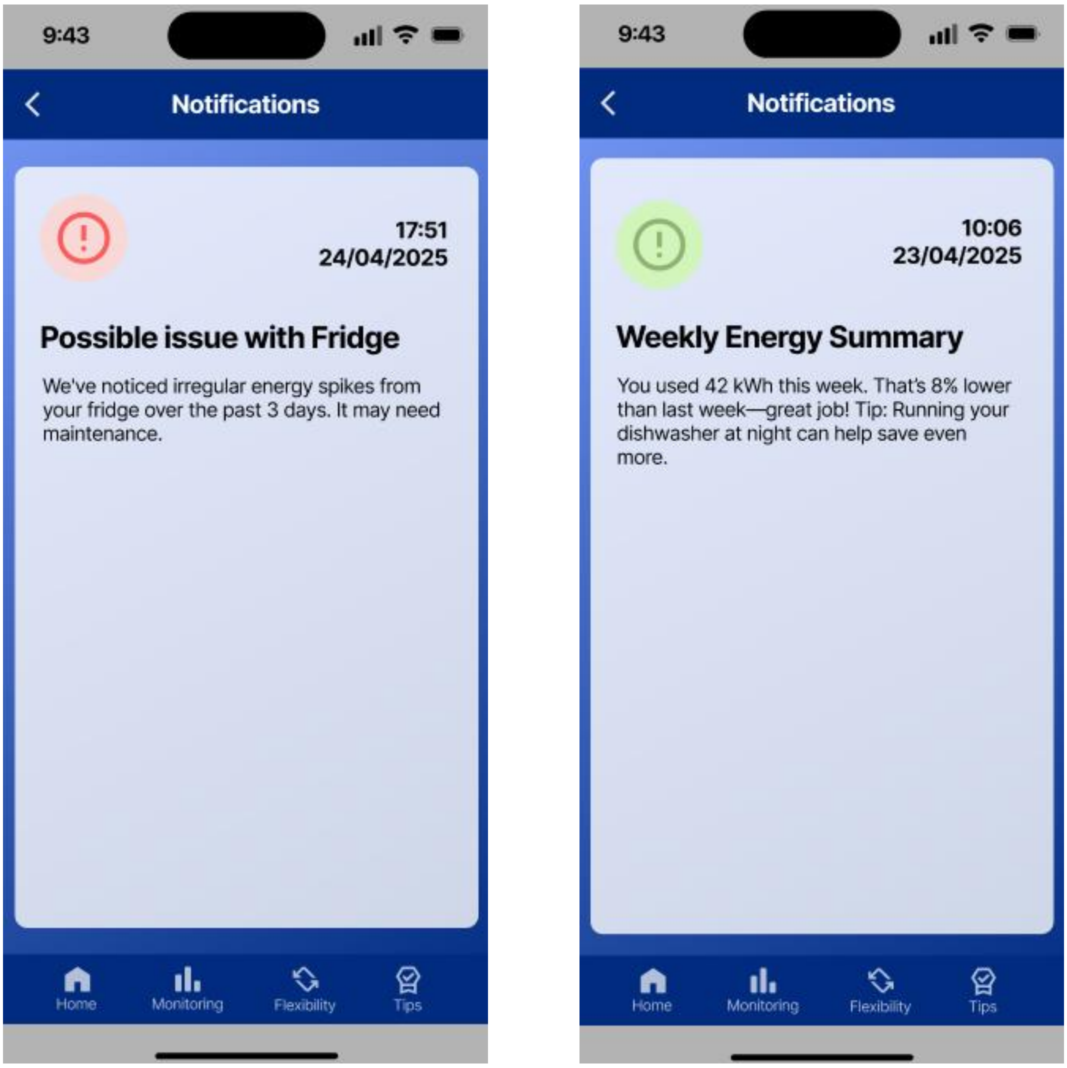


Figure 23: ECLIPSE user app – Notifications (2)

The user profile section is also accessible from the top menu. In this section, users can adjust their preferences regarding notifications, security and personal information. Figure 24, Figure 25, and Figure 26 provide some examples on the type of information included.

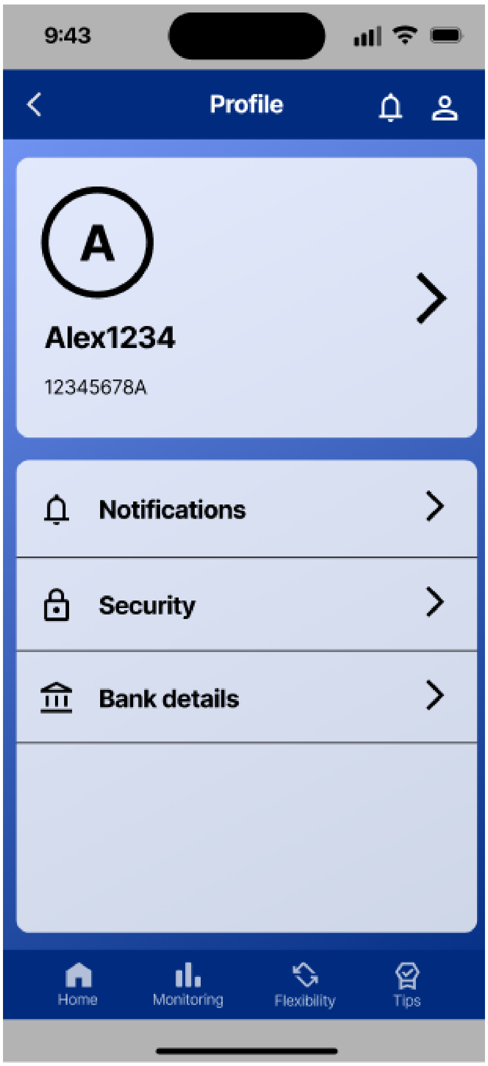


Figure 24: ECLIPSE user app – User profile

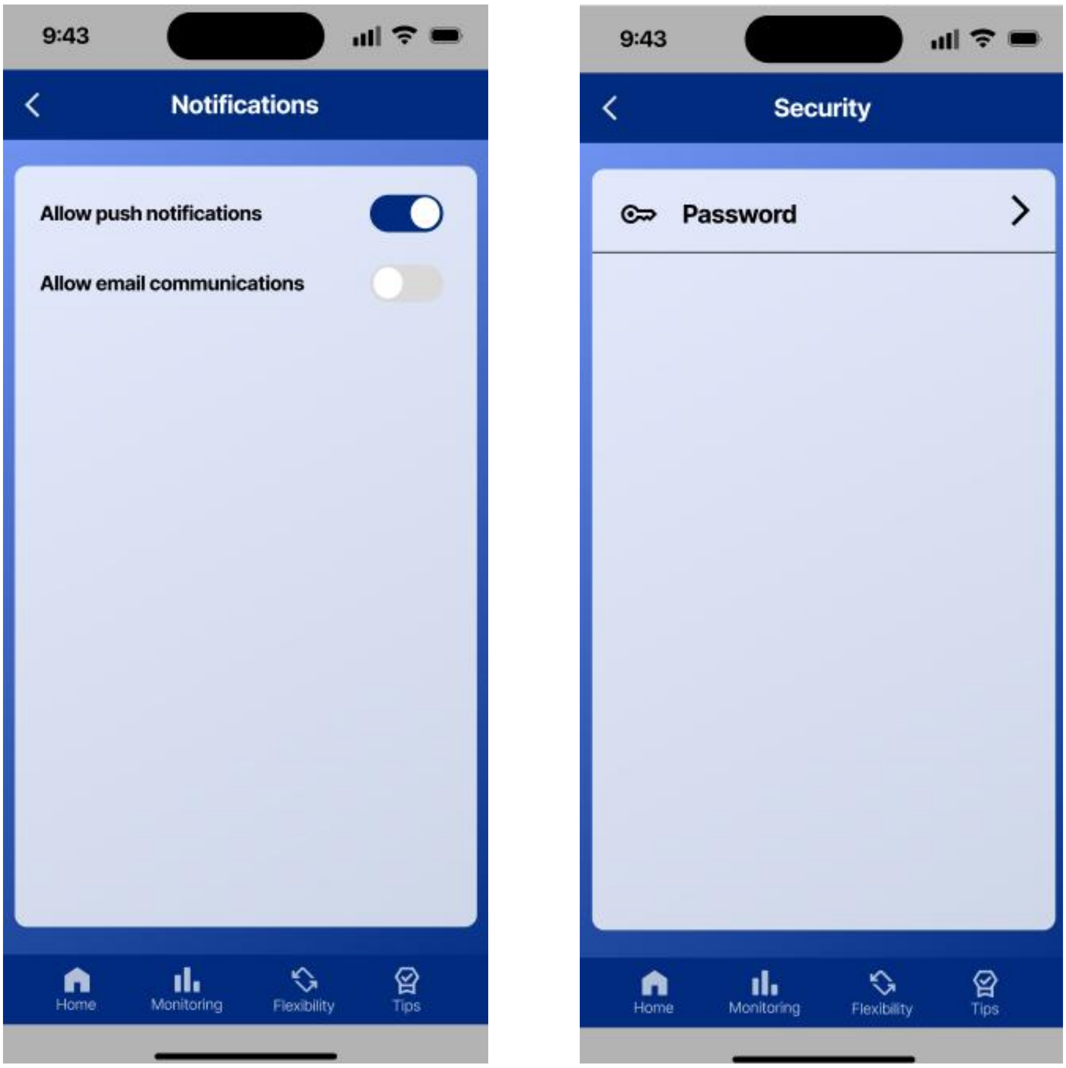


Figure 25: ECLIPSE user app – User settings (1)

Figure 26: ECLIPSE user app – User settings (2)

3.4. PILOT IMPLEMENTATION OF ECLIPSE CERF

This section provides the details of the implementation of ECLIPSE CERF in the 13 demo pilots of the project. Each section is structured as follows:

1. First, an overview of the pilot and its deployment plan is provided, where the roadmap presented in Section 2.1 is instantiated and adapted.

2. Then, the specific components of the pilot to be integrated in the CERF are described, included their technical details. The elements are divided into three main categories: data spaces/data sources, energy services, and end user applications. The information is structured in templates per type of element.
3. Finally, some identified components that will be implemented in more than one pilot are included.

3.4.1. DEMO #1 (FRANCE)

3.4.1.1. PILOT OVERVIEW

Demo #1 Summary: The French demo, focuses on leveraging existing demand-response infrastructure to engage residential consumers in energy flexibility services.

The deployment plan outlines the following activity streams:

1. **API interface development** (Integration): Key technical step aimed at enabling secure and interoperable data exchange between D4G and Voltalis systems. This is essential to facilitate the communication of flexibility data and the activation of services, thus allowing different flexibility models to be tested.

2. **Adaptation of existing APP** (Adaptation): The current Voltalis consumer-facing application will be adapted to integrate new features and interfaces required by the ECLIPSE framework. The

adaptation will support transparency and user engagement by delivering personalized energy insights and control functions.

3. **UI** (Consumer Engagement): Profile, segment, and enrol residential consumers, enabling the enrolment of participants into the demo. This includes providing a clear consent and data governance model in line with GDPR and ECLIPSE data ethics guidelines.

4. **Physical pilot installation France** (deployment): Installation of Voltalis demand-response equipment at residential sites, enabling real-time modulation of household loads, including device rollout, network integration.

5. **Virtual Pilot (Estonia, Denmark, Finland, Belgium)** (deployment): This activity scopes in a cross-border digital simulation of the French demo architecture in various EU contexts. The virtual pilot supports scalability testing, regulatory mapping, and interoperability assessments across different grid and market environments.

6. **Testing** (deployment): Validation of system performance through end-to-end testing of devices, data exchange, and user interaction, ensuring integrity, responsiveness, and platform resilience, reducing risks and backing technical readiness.

7. **Extract conclusions for deliverable** (deployment): Consolidating findings from the pilot.

Each activity is aligned with the broader integration roadmap of ECLIPSE, although the detailed month-by-month timeline still needs to be consolidated. These efforts enable the French Demo #1 to serve as a replicable model for residential consumer empowerment and grid interaction.

3.4.1.2. DATA SPACES AND DATA SOURCES

Table 34: Demo #1 (France) – Voltalis Cloud Platform

Name	Voltalis Cloud Platform
Brief description	Residential energy flexibility management technologies and domestic appliance control through smart box meters
Pilot(s) and UC(s)	UC FR 3.1 Non-economically driven consumer flexibility participation in power system UC FR 3.2 Increasing flexibility potential distributed energy resources (DER) through explicit and implicit demand response (France, Estonia) UC FR 3.3 Near real-time measurements with threshold notification UC FR 3.4 Non-economic incentive UC FR 3.5 Energy Tips and goal UC FR 3.6. Extreme grid situation management

Type(s) of data managed	• Energy consumption from heating devices
Communication method	• REST API (HTTP) • TCP/IP (proprietary protocol)
Data format	• JSON • Proprietary format
Open access	No
Documentation	Private
Leader/responsible	Voltalis
Integration status	Integrated

Table 35: Demo #1 (France) – D4G Insights Platform

Name	**D4G Insights Platform**
Brief description	Multi-DER flexibility orchestration
Pilot(s) and UC(s)	UC FR 3.2 Increasing flexibility potential distributed energy resources (DER) through explicit and implicit demand response (France, Estonia)

Type(s) of data managed	• Energy data collected from DCBel Home Energy Stations which include solar PV with DC inverter, home battery, bidirectional EV charger (V2G) • Market data and bid activation data collected from FSP (Voltalis) or System Operator or Market operator
Communication method	• DER <> Tech aggregation: MQTT protocol • Tech Aggregation <> FSP / Market: Rest API of subscription to Apache Kafka topic • IEC 62746-4, IEC 62325 ESMP
Data format	JSON or XML
Open access	Yes, provided user consent is obtained
Documentation	Not available
Leader/responsible	D4G
Integration status	Integrated

Table 36: Demo #1 (France) – System Operator

Name	**System Operator**
Brief description	Participation of distributed energy resources to balancing mechanisms and congestion management for TSOs and DSOs, through flexibility and demand side management

Pilot(s) and UC(s)	UC FR 3.2 Increasing flexibility potential distributed energy resources (DER) through explicit and implicit demand response
Type(s) of data managed	• Spot prices and prices on different flexibility markets • Weather forecast data
Communication method	• Rest API or Kafka API (Voltalis) • IEC 62746-4 (D4G) • IEC 62325 ESMP (D4G)
Data format	JSON or XML
Open access	Yes
Documentation	Not available
Leader/responsible	Voltalis, D4G
Integration status	Integrated

Table 37: Demo #1 (France) – Dcbel's Home Energy Station

Name	Dcbel's Home Energy Station
Brief description	Management of energy-intensive equipment Baseline profiles and reference energy curves

Pilot(s) and UC(s)	UC FR 3.2 Increasing flexibility potential distributed energy resources (DER) through explicit and implicit demand response (France, Estonia)
Type(s) of data managed	• EV/EV Charger data (state of charge, power, current, voltage) • Home battery energy curve • PV generation data
Communication method	• MQTT protocol to collect energy time series • Rest API or Kafka API to communicate with FSP • IEC 62746-4
Data format	JSON or XML
Open access	Yes, provided user consent is obtained
Documentation	https://www.dcbel.energy/fr/
Leader/responsible	Voltalis, D4G
Integration status	Integrated

Table 38: Demo #1 (France) – EcoWatt system

Name	**EcoWatt system**

Brief description	RTE's (French TSO) platform with information about the status of the transmission network.
Pilot(s) and UC(s)	UC FR 3.6. Extreme grid situation management
Type(s) of data managed	• Daily forecasts of the status of the transmission network • Alerts on critical situations in the transmission network
Communication method	• REST API (HTTP) • TCP/IP (proprietary protocol)
Data format	• JSON • Proprietary format
Open access	Yes
Documentation	https://data.rte-france.com/catalog/-/api/consumption/Ecowatt/v5.0
Leader/responsible	Voltalis
Integration status	Integrated

3.4.1.3. ENERGY SERVICES

Table 39: Demo #1 (France) – Virtual simulations (digital twin)

Name	**Virtual simulations (digital twin)**

Brief description	As part of the ECLIPSE project, an advanced heat pump simulator is being developed for participating countries such as Finland, Denmark, Belgium, and Estonia. This digital simulator accurately reproduces the behaviour of heat pumps when they receive modulation signals for energy demand management. The planned hybrid digital sites will integrate Voltalis' heat pump simulator, D4G's digital twin, and the jointly developed API. This infrastructure will enable smooth and secure communication between the different technologies, facilitating the exchange of flexibility data. This simulator, specifically adapted to the needs of the ECLIPSE project, allows the evaluation of various energy flexibility scenarios without requiring physical installation. It represents an innovative solution for testing diffuse load shedding capabilities and residential load aggregation in different contexts, taking into account the specificities of national markets and regional climatic characteristics. This approach will facilitate the adaptation of flexibility strategies to different European contexts.
Inputs	• Residential consumption data • Typical load profiles • Flexibility parameters • Weather data

Outputs	• Flexibility capacity • Estimated consumption forecasts • Optimization scenarios • Performance reports
Pilot(s) and UC(s)	UC FR 3.1 Non-economically driven consumer flexibility participation in power system UC FR 3.2 Increasing flexibility potential distributed energy resources (DER) through explicit and implicit demand response (France, Estonia, Finland, Denmark, and Belgium)
Status	Simulator of heat pump under development
Technologies used	API Rest
Documentation	https://www.digital4grids.com/
Leader/responsible	Voltalis, D4G

Table 40: Demo #1 (France) – Flexibility estimation

Name	Flexibility estimation
Brief description	Flexibility capacity per DER is estimated by analysing historical energy data reflecting consumer behaviour and consumption typical habits. This allows to anticipate whether the consumer is able to offer flexibility at a given moment in time through a given DER.

Inputs	• Historical consumption • Data Equipment characteristics • DER flexibility parameters • Technical installation constraint
Outputs	• Flexibility capacity estimation • Consumption baseline • Modulation potential • Availability forecasts • Performance indicators
Pilot(s) and UC(s)	UC FR 3.1 Non-economically driven consumer flexibility participation in power system UC FR 3.2 Increasing flexibility potential distributed energy resources (DER) through explicit and implicit demand response (France, Estonia, Finland, Denmark, and Belgium) UC FR 3.3 Near real-time measurements with threshold notification UC FR 3.4 Non-economic incentive
Status	Developed
Technologies used	API Rest
Documentation	https://www.digital4grids.com/

Leader/responsible	Voltalis, D4G

Table 41: Demo #1 (France) – Energy market

Name	**Energy market**
Brief description	The demo use case involves the exchange of market level message allowing to activate and monetize flexibility. This includes enabling an FSP as market participant to receive a flexibility offer which he can further propagate into his bid within a larger energy portfolio. Market exchanges also involve bid activation messages and transaction settlement messages.
Inputs	• Flex offer message • Reference energy curve for DER Group / Service providing Group
Outputs	• Bid activation message • Imbalance message (if applicable)
Pilot(s) and UC(s)	UC FR 3.1 Non-economically driven consumer flexibility participation in power system UC FR 3.2 Increasing flexibility potential distributed energy resources (DER) through explicit and implicit demand response (France, Estonia, Finland, Denmark, and Belgium) UC FR 3.4 Non-economic incentive
Status	Developed

Technologies used	API REST
Documentation	EPEX platform
Leader/responsible	Voltalis

3.4.1.4. END USER APPLICATIONS

Table 42: Demo #1 (France) – myVoltalis App

Name of the app	myVoltalis App
Brief description	Management of heating and water heater control
Pilot(s) and UC(s)	UC FR 3.1 Non-economically driven consumer flexibility participation in power system UC FR 3.2 Increasing flexibility potential distributed energy resources (DER) through explicit and implicit demand response (France, Estonia, Finland, Denmark, Belgium) UC FR 3.3 Near real-time measurements with threshold notification UC FR 3.4 Non-economic incentive UC FR 3.5 Energy Tips and goal UC FR 3.6. Extreme grid situation management

Expected functionalities	• User registration and authentication • Visualization and management tools • Energy efficiency tips • Assess financial and carbon footprint benefits of energy markets participation and DSR programs • Combination of explicit and implicit flexibility (Voltalis + D4G) in Finland, Denmark, and Belgium will focus on explicit flexibility
Additional information	Estonia, Finland, Denmark, and Belgium will use simulated data
Leader/responsible	Voltalis
Development status	Developed

Table 43: Demo #1 (France) – D4G

Name of the app	**D4G Insights app & DCBel Chorus app**
Brief description	Management of EV and PV installations and flexibility monetization with an FSP (Voltalis)
Pilot(s) and UC(s)	UC FR 3.2 Increasing flexibility potential distributed energy resources (DER) through explicit and implicit demand response (France, Estonia)

Expected functionalities	• User registration and authentication • DER registration and pre-qualification • Visualization and management tools • Energy monitoring • Price and energy offer monitoring • Assess financial and carbon footprint benefits of energy markets participation and DSR programs • Flexibility estimation and transmission of flex offers to FSPs in regards to different proposed flexibility programs • Flex bid activation and disaggregation to DERs • Flex observability and revenue settlement (transaction log book) • Combination of explicit and implicit flexibility (Voltalis + D4G)
Additional information	Estonia will use simulated data
Leader/responsible	D4G
Development status	Developed, under improvements

3.4.2. DEMO #2 (AUSTRIA)

3.4.2.1. PILOT OVERVIEW

Demo #2 Summary: The Austrian demo focuses on unlocking load-shifting potential within residential energy communities through smart monitoring and consumer-facing tools. Led by FHOOE, the demo aims to create a local energy ecosystem in which both prosumers and community operators can benefit from data-driven energy management.

The deployment and integration plan includes the following activities:

1. **Development of the initial user interface** (Integration): The UI development scopes to act as the main gateway for consumers to interact with the ECLIPSE platform, providing access to visualizations, energy insights, and service features.
2. **Monitoring and visualization via end-customer APP** (Integration): Includes integrating real-time and historical data (consumption/production), enabling households to make informed energy decisions and participate in flexibility schemes.
3. **Load shifting potential development** (Integration): Aimed at identifying, modelling, and enabling load flexibility within the community, with potential links to automated or semi-automated control mechanisms.
4. **Energy saving recommendation** (Integration): Integration of tailored energy-saving suggestions into UI, based on consumption data and

behavioural insights, enhancing user value and facilitating active demand-side management by offering actionable guidance.

5. **Digital Twin using AIIDA** (Integration): Creation of a localized digital twin for households or communities using the AIIDA framework, enabling predictive control and energy efficiency recommendations.
6. **Energy communities' module** (Integration): Designed to support the management of ECs.
7. **Home automation** (integration of IoT devices using matter/thread/Loxone) (Integration): Connecting consumer IoT devices to the ECLIPSE platform via interoperable standards, for automated device control bringing flexibility, comfort, and energy efficiency within smart homes.
8. **Deploy functional modules** (Deployment): Installation and activation of all components required for the demonstration, including data pipelines, user dashboards, and control logic, transitioning the demo to live operation.
9. **Deploy EDDIE framework for historical validated data** (Deployment): To manage and analyse energy data, supporting long-term insights, baseline calculations, and evaluation of impact.
10. **Deploy AIIDA for near real-time data** (Deployment): To process and act on near real-time data streams, enabling responsive features (e.g.,

live monitoring, smart notifications, adaptive control decisions) based on current grid and user conditions.

11. **Marketplace connection** (Adaptation): Interface with a local or project-wide marketplace, enabling consumers and ECs to offer and trade flexibility or surplus energy.
12. **DSO onboarding** (Consumer Engagement): To align data flows, and interoperability expectations with DSOs establishing technical specifications.
13. **Reach out to test customers** (Consumer Engagement): Engagement with residential prosumers and EC actors willing to participate in the demo.
14. **Customer acquisition** (Consumer Engagement): Onboarding of users into the demo environment (registration, consent capture, technical checks, and installation of tools/apps).
15. **Adapt application based on feedback** (Adaptation): Iterative improvement of the app based on participants' feedback, including UI refinements, new features, and clarified instructions to enhance engagement and satisfaction.

3.4.2.2. DATA SPACES AND DATA SOURCES

Table 44: Demo #2 (Austria) – AIIDA

Name	AIIDA
Brief description	Provides access to near real-time end user data
Pilot(s) and UC(s)	UC AT 1.1: Personalised messages for consumer flexibility based on economic benefits UC AT 2.1: Personalised messages focusing on non-economic incentives for benefits of the system UC AT 3.1: Energy efficiency potential at aggregated level UC AT 4.1: Extreme Grid Situation Management UC AT 5.1: Energy Awareness and Education
Type(s) of data managed	• End user data
Communication method	MQTT
Data format	EDDIE CIM Extension for Near-real time data
Open access	Yes
Documentation	https://eddie-web.projekte.fh-hagenberg.at/architecture/aiida/aiida.html
Leader/responsible	FHOOE

Integration status	Integrated in EDDIE, to be evolved

Table 45: Demo #2 (Austria) – Smart meters in Austria

Name	**Smart meters in Austria**
Brief description	Provide real-time energy monitoring for the energy app
Pilot(s) and UC(s)	UC AT 1.1: Personalised messages for consumer flexibility based on economic benefits UC AT 2.1: Personalised messages focusing on non-economic incentives for benefits of the system UC AT 3.1: Energy efficiency potential at aggregated level UC AT 4.1: Extreme Grid Situation Management UC AT 5.1: Energy Awareness and Education
Type(s) of data managed	• Energy consumption
Communication method	• Supported Interfaces: RJ12, Infrared, wMBUS • Transmission Protocols: DSMR, M-Bus, HDLC, MEP
Data format	DLMS/COSEM
Open access	Yes
Documentation	https://www.dlms.com/core-specifications/#COSEM

Leader/responsible	FHOOE
Integration status	Integrated through AIIDA

Table 46: Demo #2 (Austria) – Home Automation Devices

Name	Home Automation Devices
Brief description	To provide the energy app with the possibility for interfacing with external automated energy management. Example: Loxone.
Pilot(s) and UC(s)	UC AT 1.1: Personalised messages for consumer flexibility based on economic benefits UC AT 2.1: Personalised messages focusing on non-economic incentives for benefits of the system
Type(s) of data managed	• Near real-time end user data
Communication method	Loxone: MQTT Matter: Matter Standard
Data format	Loxone: Vendor Proprietary Matter: Matter Standard
Open access	Loxone: No Matter: Yes

Documentation	https://csa-iot.org/all-solutions/matter/
Leader/responsible	FHOOE
Integration status	Integrated through AIIDA

3.4.2.3. ENERGY SERVICES

Table 47: Demo #2 (Austria) – Consumption-related recommendations

Name	Consumption-related recommendations
Brief description	The service facilitates consumption-related recommendations (individual and aggregated), allowing users to capitalize on off-peak electricity rates and reduce overall costs. (Part of the End Customer App)
Inputs	• Individual real-time and historical energy data (AIIDA, EDDIE) • Aggregated real-time and historical energy data (AIIDA, EDDIE)
Outputs	• Personalized economic flexibility recommendations • Personalized non-economic flexibility recommendations • Community-specific energy saving messages

Pilot(s) and UC(s)	UC AT 1.1: Personalised messages for consumer flexibility based on economic benefits UC AT 2.1: Personalised messages focusing on non-economic incentives for benefits of the system UC AT 3.1: Energy efficiency potential at aggregated level
Status	Newly developed
Technologies used	• OpenADR • MQTT (internal and external communication) • Push Notifications in Customer App (Firebase Cloud Messaging) • Docker (Services are packaged as docker containers) • k3s (Services are installed on lightweight Kubernetes Cluster)
Documentation	https://www.openadr.org/ https://mqtt.org/ https://firebase.google.com/docs/cloud-messaging https://www.docker.com/ https://k3s.io/
Leader/responsible	FHOOE

Table 48: Demo #2 (Austria) – Extreme grid situation messages

Name	Extreme grid situation messages
Brief description	The system generates critical messages and alerts about extreme grid situations based on external data signals. By leveraging AIIDA's near-real-time data access, the app provides immediate, actionable information during critical energy infrastructure scenarios, enabling rapid response and user awareness. (Part of the End Customer App)
Inputs	• AIIDA's near-real-time data • DSO external signals about grid stress
Outputs	• Targeted, informative grid situation messages • Specific user guidance
Pilot(s) and UC(s)	UC AT 4.1: Extreme Grid Situation Management
Status	Newly developed
Technologies used	• OpenADR • MQTT (Internal and external communication) • Push Notifications in Customer App (Firebase Cloud Messaging)

	https://www.openadr.org/ https://mqtt.org/ https://firebase.google.com/docs/cloud-messaging https://www.docker.com/ https://k3s.io/
Leader/responsible	FHOOE

Table 49: Demo #2 (Austria) – Energy efficiency guidance messages

Name	**Energy efficiency guidance messages**
Brief description	Comprehensive, user-friendly energy efficiency guidance, offering general tips and practical advice to help users improve their energy consumption habits. The system delivers personalized, actionable recommendations for sustainable energy use. (Part of the End Customer App)
Inputs	• User and contextual energy data (AIIDA, EDDIE)
Outputs	• Personalized and general energy efficiency guidance
Pilot(s) and UC(s)	UC AT 5.1: Energy Awareness and Education
Status	Newly developed
Technologies used	N/A

Documentation	Under development
Leader/responsible	FHOOE

3.4.2.4. END USER APPLICATIONS

Table 50: Demo #2 (Austria) – End Customer App

Name of the app	End Customer App

Brief description	The End Customer App is a comprehensive energy management solution that integrates various data sources and smart home technologies. Its key features include: • Visualization: Provides graphical representations of energy usage and other relevant data. • Monitoring: Allows users to track their energy consumption in real-time. • Acceptance: refers to user consent for data sharing or acceptance of recommendations. • Load shifting potential: Suggests optimal times to use energy-intensive appliances. • Energy saving recommendations: Offers personalized tips to reduce energy consumption. • Digital twin: Creates a virtual model of the user's energy ecosystem for analysis and optimization. The features provided above can also be considered as third-party ESCOs providing these services that can be executed on AIIDA. The app leverages both historical and real-time data, connecting to smart meters, home automation devices, and energy communities. It aims to empower end users with tools for more efficient energy management and conservation.

Pilot(s) and UC(s)	UC AT 1.1: Personalised messages for consumer flexibility based on economic benefits UC AT 2.1: Personalised messages focusing on non-economic incentives for benefits of the system UC AT 3.1: Energy efficiency potential at aggregated level UC AT 4.1: Extreme Grid Situation Management UC AT 5.1: Energy Awareness and Education

Expected functionalities	• Optimized energy management (individual and aggregated)
	  ○ Analyse economic and non-economic optimization opportunities
	  ○ Create personalized economic and non-economic flexibility recommendations
	• Energy consumption patterns are adjusted by user(s) to optimize savings.
	• Integration with smart meters and home automation systems
	• Generate critical messages and alerts about extreme grid situations based on external data signals
	  ○ Receiving external (DSO) signal about grid stress
	  ○ Create targeted, informative grid situation messages
	  ○ Provide specific user guidance
	• Provide comprehensive, user-friendly energy efficiency guidance, offering general tips and practical advice to help users improve their energy consumption habit
	  ○ Basic user profile created
	  ○ Minimum data available for contextual recommendations
	  ○ User consent for receiving guidance

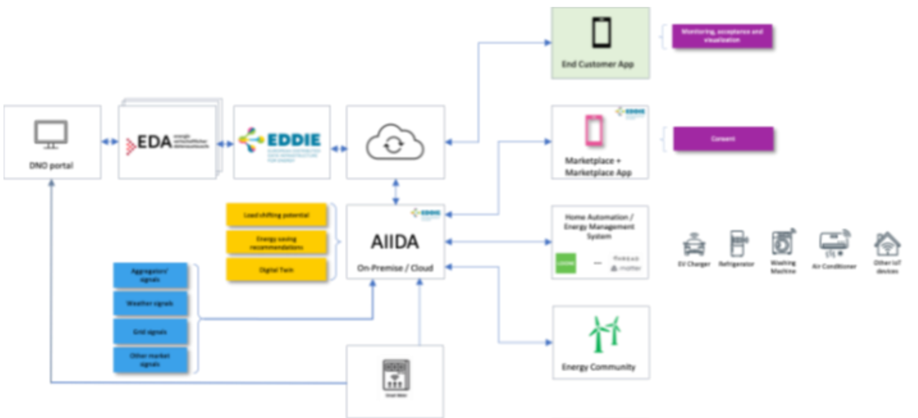
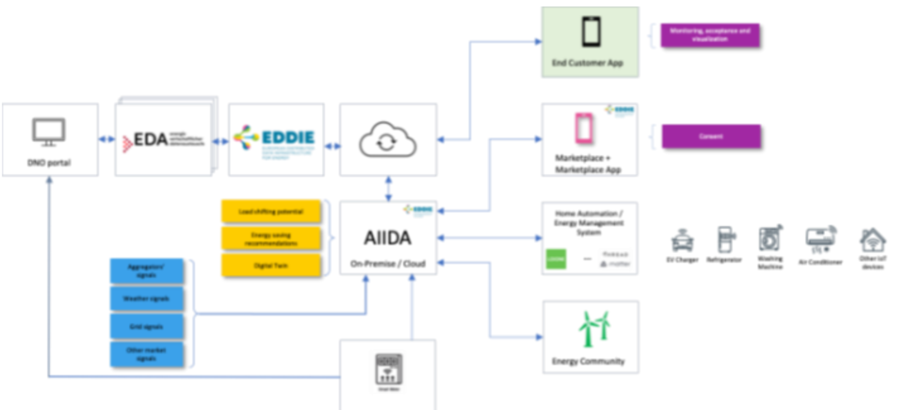
	○ Analyse available user and contextual energy data ○ Develop personalized and general energy efficiency guidance
Additional information	Based on EDDIE framework for Historical Validated Data and AIIDA for near real-time data access  Figure 27: EDDIE framework (with End Customer App)
Leader/responsible	FHOOE
Development status	Under development

Table 51: Demo #2 (Austria) – Data Marketplace App

Name of the app	Data Marketplace App

Brief description	The Marketplace App allows the user to: 1. Discover services that can be installed locally on the user's device 2. Discover "data requests" that are used e.g. for the implementation of energy communities or to receive economic and non-economic incentives 3. Mange the user consent for data sharing (accept, reject, revoke, ...)

Expected functionalities	• Manage consent for existing data sharing
	    o Give consent to share data according to a policy
	    o Reject consent
	    o Revoke existing consents

Additional information	Based on EDDIE framework for Historical Validated Data and AIIDA for near real-time data access  Figure 28: EDDIE framework (with Data Marketplace App)
Leader/responsible	FHOOE

Development status	Under development

3.4.3. DEMO #3 (SPAIN)

3.4.3.1. PILOT OVERVIEW

Demo #3 Summary: The Spanish pilot aims to demonstrate enhanced stakeholder interaction through the integration of DSOs, consumers, and internal assets (e.g., employees and fleets). The pilot focuses on creating demonstrable, scalable UCs and enabling digital interfaces that foster active engagement.

The deployment and integration activities include:

1. **Development of demo UCs** (Integration): This foundational activity focuses on identifying and modelling practical use cases that represent how consumers and internal actors (e.g., employees and fleets) can interact with flexibility services under real-world conditions.

2. **Link DSO with SIORD** (Integration): A technical task focused on ensuring interoperability between the DSO's systems and SIORD (the Spanish data hub to unify the communication links and standardized protocols between Generation & Demand Control Centres and DSOs). This enables secure data exchange and opens participation in market mechanisms.

3. **Presentation to the customer** (Consumer Engagement): Engagement actions will include presenting the use cases and benefits to the target groups to ensure understanding and buy-in. This is especially important given the pilot's internal engagement focus (employees, fleet).

4. **Develop algorithm logics** (Integration): Design and implementation of the logic that runs the flexibility signals execution, including consumption forecasts, event triggers, and control rules that emphasize decisions.

5. **Link SIORD with retailer** (Integration): Develop the data interface between SIORD and the retailer's systems.

6. **Adapt current APPs** (Adaptation): Refinement of existing digital tools to support new features introduced in the demo, including visualization of energy insights, notification systems, and user consent management.

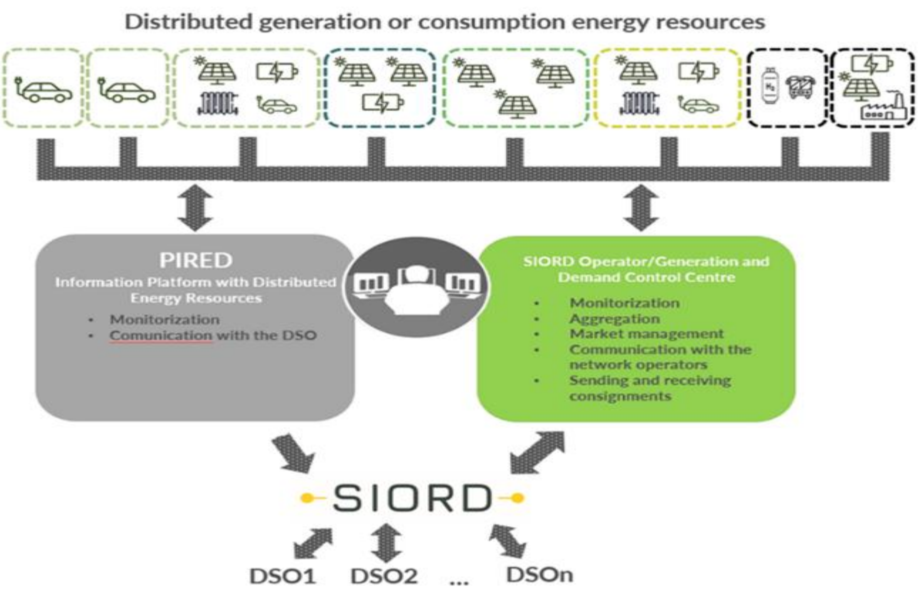
7. **Buy hardware** (Deployment): For field testing, e.g., sensors, EV chargers, load control devices. This step is essential for equipping pilot participants (e.g., households, fleet users) with the tools required to engage in flexibility.

8. **Tests in field** (Deployment): Execution of functional and performance tests under real-world conditions, verifying system responsiveness, data integrity, user interaction flows, and operational stability.

9. **Extract conclusions for deliverable** (Deployment): Final analysis of results, including technical performance, user feedback, and lessons learned.

3.4.3.2. DATA SPACES AND DATA SOURCES

Table 52: Demo #3 (Spain) – SIORD

Name	SIORD
Brief description	Neutral flexibility platform to facilitate the interchange of real-time information between the DSOs and the significative generation and demand installations (greater than 1 MW, with control centres assigned).  Figure 29: Architecture of Demo #3 (Spain)
Pilot(s) and UC(s)	UC ES 1.1: Smart EV Residential Charging (I) UC ES 2.1: Smart EV Residential Charging (II) UC ES 4.1: Smart EV Charging in Overdemand Grid Status UC ES 4.2: Smart EV Charging in Private Companies

Type(s) of data managed	• DSO needs at specific points of the network (voltage, power, location, etc.) • Flexibility options
Communication method	IEC 60870-5-104 (Other protocols supported: ICCP, Modbus Master, DNP3 Master, OPC-UA Client, Client OPC-XML-DA, API REST).
Data format	JSON, CSV
Open access	No. Access to SIORD is via VPN IPsec, a secured and encrypted channel. Additionally, the Global Protect program can be used to access SIORD. Access to the platform is through username/password. These users are provided by SIORD.
Documentation	Public documentation (context and technical specifications) available in: Consulta - aelec
Leader/responsible	i-DE
Integration status	Integrated

Table 53: Demo #3 (Spain) – CPO/FSP database

Name	**CPO/FSP database**
Brief description	This database holds the EV charging preferences from the consumer. The client can define, modify and consult them.

Pilot(s) and UC(s)	UC ES 1.1: Smart EV Residential Charging (I) UC ES 2.1: Smart EV Residential Charging (II) UC ES 4.1: Smart EV Charging in Overdemand Grid Status UC ES 4.2: Smart EV Charging in Private Companies
Type(s) of data managed	• Customer EV charging preferences • Charging schedule (and from charging slot reservations)
Communication method	Preferences are stored, using a secure API that connects the app to the CEH platform.
Data format	S3 DynamoDb files (in Cloud platform). Confirmation pending.
Open access	Not accessible from third-party applications for security reasons.
Documentation	Not public
Leader/responsible	i-DE
Integration status	Integrated

Table 54: Demo #3 (Spain) – EV Charge Points

Name	**EV Charge Points**
Brief description	The Spanish demonstrator will test smart charging for both residential and private users, combining user preferences with the needs from the DSO Control Centre.

Pilot(s) and UC(s)	UC ES 1.1: Smart EV Residential Charging (I) UC ES 2.1: Smart EV Residential Charging (II) UC ES 4.1: Smart EV Charging in Overdemand Grid Status UC ES 4.2: Smart EV Charging in Private Companies
Type(s) of data managed	• Energy consumption • Charging commands
Communication method	Modbus RTU // IEC 61851
Data format	JSON, CSV
Open access	Yes
Documentation	To be defined. Inherent to each manufacturer.
Leader/responsible	i-DE
Integration status	Integrated

3.4.3.3. ENERGY SERVICES

Table 55: Demo #3 (Spain) – Grid management system (Spectrum)

Name	**Grid management system (Spectrum)**

Brief description	Through network status monitoring (DSO Spectrum system), instructions will be sent to charging points (also via SIORD and retailer/s as intermediate parties) to align user preferences with network needs.
Inputs	• Charging station capacity • Network status • Flexibility aggregated data from users
Outputs	• Flexibility options to solve a congestion in the network
Pilot(s) and UC(s)	UC ES 1.1: Smart EV Residential Charging (I) UC ES 2.1: Smart EV Residential Charging (II) UC ES 4.1: Smart EV Charging in Overdemand Grid Status UC ES 4.2: Smart EV Charging in Private Companies
Status	Under development the flexibility module
Technologies used	Network observability using IEC 104 protocol
Documentation	Spectrum Power Advanced Distribution Management - Siemens ES (brochure and manuals published)
Leader/responsible	i-DE

Table 56: Demo #3 (Spain) – Private fleet optimization algorithm

Name	**Private fleet optimization algorithm**
Brief description	Optimize the charging of a fleet of company vehicles when the charging requests or needs exceed the capacity of the charging station or local grid.
Inputs	• Company EV charging preferences • Charging station capacity • Local grid capacity
Outputs	• Optimized fleet charging plan
Pilot(s) and UC(s)	UC ES 4.2: Smart EV Charging in Private Companies
Status	Under development
Technologies used	Algorithm that analyses the charging necessities from the fleet and proposes the sequence and duration of vehicle fleet charging.
Documentation	Under development
Leader/responsible	i-DE

3.4.3.4. END USER APPLICATIONS

Table 57: Demo #3 (Spain) – End user app

Name of the app	End user app
Brief description	The Retailer has their APP already developed, to which it will be added a flexibility module
Pilot(s) and UC(s)	UC ES 4.1: Smart EV Charging in Overdemand Grid Status UC ES 1.1: Smart EV Residential Charging (I) UC ES 2.1: Smart EV Residential Charging (II)UC ES 4.2: Smart EV Charging in Private Companies
Expected functionalities	• EV charger management: charging program selection, service preferences, etc. • Optimization algorithm according to user preferences and grid status
Additional information	In the APP's flexibility module, the user will include any restrictions they consider relevant to their EV charger, so that they only receive proposals for consumption/generation modifications that are compatible with them.
Leader/responsible	i-DE
Development status	Developed, with the exception of the flexibility module for EVs

3.4.4. DEMO #4 (BULGARIA)

3.4.4.1. PILOT OVERVIEW

Demo #4 Summary: The Bulgarian demo focuses on empowering end-users particularly (residential and small business) through actionable insights and targeted energy efficiency support. The demo scopes in leveraging informational and digital tools to test a low-barrier model of consumer engagement and grid integration.

The deployment and integration activities include:

1. **Develop demo UCs and interface (Integration):** Defining representative UCs and a corresponding UI that will support data exchange and user interaction, facilitating users' understanding patterns and implementing optimization strategies.

2. **Prepare and adapt TSO information systems to provide data to the ECLIPSE Energy App** (Adaptation): Update pilot leader's systems to support consumer data processing, interacting with the ECLIPSE digital services.

3. **Presentation and promotion of the ECLIPSE Energy App** (Consumer engagement): Will be launched to raise awareness about the new web platform, including digital and print channels (e.g., social media, newsletters, press releases).

4. **Test in field** (Deployment): Execution of functional and performance tests under real-world conditions.

5. **Extract conclusions for deliverable** (Deployment): Final analysis of results, including technical performance, user feedback, and lessons learned.

3.4.4.2. DATA SPACES AND DATA SOURCES

Table 58: Demo #4 (Bulgaria) – ESO systems

Name	ESO systems
Brief description	Provide for the consumers a mobile application, which will inform in real time for the current generation, load and prices of the energy and estimated imbalance prices and the status of the grid – contingencies, planned outages and emergencies. It will give general advice to all customers about energy consumption optimization, based on energy prices. The consumers who have their own generation and/or energy storage systems (prosumers) or EVs may receive personalized advice for charging and discharging.
Pilot(s) and UC(s)	UC BG 3.1: Energy efficiency potential UC BG 4.1: Energy consumption optimization tips - alert
Type(s) of data managed	• Grid status • Energy pricing • Real-time grid conditions • Grid demand and renewables share • TSO request during periods of grid imbalance

Communication method	HTTPS
Data format	XML, CSV, JSON
Open access	Yes
Documentation	Under development
Leader/responsible	ESO, ETRA
Integration status	Ongoing

3.4.4.3. ENERGY SERVICES

Table 59: Demo #4 (Bulgaria) – Energy savings and recommendations

Name	Energy savings and recommendations
Brief description	Optimize Energy Consumption – Enable consumers to shift energy usage to lower-cost periods, reducing their overall electricity bills. Improve Consumer Awareness – Provide real-time insights that help users make informed decisions about their energy usage.

Inputs	• TSO data (ESO systems) • Market • Energy prices • Imbalance prices
Outputs	• Advice about energy consumption planning and optimization; • Statistics about power generation and load; • Energy consumption optimization tips based on expected changes in the market
Pilot(s) and UC(s)	UC BG 3.1: Energy efficiency potential
Status	Pending
Technologies used	ECLIPSE Energy App
Documentation	Under development
Leader/responsible	ESO, ETRA

Table 60: Demo #4 (Bulgaria) – System status alerts

Name	System status alerts
Brief description	An alert status of the system (if present) and additional guidance will be provided for further optimization of energy consumption.

Inputs	• Grid status/problem detected (ESO systems)
Outputs	• Power optimization tips
Pilot(s) and UC(s)	UC BG 4.1: Energy consumption optimization tips - alert
Status	Under development
Technologies used	ECLIPSE Energy App
Documentation	Under development
Leader/responsible	ESO, ETRA

3.4.4.4. END USER APPLICATIONS

Table 61: Demo #4 (Bulgaria) – Mobile app

Name of the app	**Mobile app**
Brief description	Provides information of the status of the grid (including detected problems) and other inputs to generate consumption optimization recommendation messages.
Pilot(s) and UC(s)	UC BG 3.1: Energy efficiency potential UC BG 4.1: Energy consumption optimization tips - alert

Expected functionalities	• Future possibilities of consumption optimization after introduction of free energy market in Bulgaria • Alert status of the system (if present) and additional guidance for further optimization of energy consumption • Collect end user feedback about application of proposed tips
Additional information	The ECLIPSE User Application (Section 3.3) will be used
Leader/responsible	ETRA, ESO
Development status	Under development by ETRA (ECLIPSE User Application)

3.4.5. DEMO #5 (SLOVENIA)

3.4.5.1. PILOT OVERVIEW

Demo #5 Summary: Focuses on engaging residential consumers and renewable energy prosumers by offering improved energy visibility, adopting consumption to the net usage tariffs, being informed about the energy savings potential, where all the services will be accessible through a user-friendly mobile application.

The following activities have been planned:

1. **Develop demo UCs** (Integration): Define specific UCs that capture how electricity distribution networks users can respond on improved provision of data, gathered from the smart meter.

2. **Development of the APP** (Integration): Developed to enable consumers to access energy insights, monitor usage patterns, and explore tariff or net metering impacts, serving as the primary digital interface between the user and the ECLIPSE platform.

3. **Test APP (Acceptance)** (Integration): To validate the APP's functionality, user experience, and data reliability, scoping in gathering user feedback to fine-tune the interface before broader deployment.

4. **Test APP (limited number of preselected users)** (Adaptation): Early-stage usability testing involving a small group of volunteer consumers, aimed at gathering feedback on the APP's clarity, value, and navigation.

5. **Presentation and popularization on the web** (Consumer Engagement): Campaign to raise awareness about the application and the demonstration goals.

6. **APP releasing – real grid users – real testing phase** (Deployment): The live version of the APP will be accessible to a wider user base.

7. **Gathering the results – interviews** (Deployment): Structured collection of feedback via user interviews.

8. **Conclusions** (Deployment): Quantitative and qualitative results from the demo.

3.4.5.2. DATA SPACES AND DATA SOURCES

Table 62: Demo #5 (Slovenia) – Moj Elektro Portal

Name	Moj Elektro Portal
Brief description	The Moj Elektro Portal – the online user portal intended for all end consumers and their authorised representatives who can access all the metering points and metering and accounting data that they are entitled to, regardless of their supplier or distribution area. It enables: • an overview and export of all available 15-minute data by metering points (received and delivered active/reactive power, • possibility of aggregation by hour, day, month, etc.), • monitoring consumption and production above the self-supply metering points, • submission of a new tax ID number for a metering point, • the submission and entry of the meter reading at a metering point. Specific usage in case of Eclipse project: portal is used as the main, already existing for the user's sign-in or entry point.

Pilot(s) and UC(s)	UC SI 1.1 Near real-time measurements with power limit notification UC SI 2.1 Energy-saving tips UC SI 3.1 Advanced analytics of production and consumption data provision
Type(s) of data managed	• 15-minute metering and accounting data from end users • Billing data • Net usage tariffs system, consumption data are split- into the net-usage tariffs elements, in accordance with the net usage scheme. • Metering point owner data
Communication method	WS/rest API: https://docs.informatika.si/mojelektro/api
Data format	Export of 15' data in XLSX or CSV formats
Open access	As SW solution, open access is not a point. Moj Elektro portal was developed dedicated for the electrical energy users.
Documentation	General description of the portal
Leader/responsible	EL
Integration status	Integrated

Table 63: Demo #5 (Slovenia) – DSO's measurement database

Name	DSO's measurement database
Brief description	Stores Smart Meter measurements
Pilot(s) and UC(s)	UC SI 1.1 Near real-time measurements with power limit notification UC SI 2.1 Energy-saving tips UC SI 3.1 Advanced analytics of production and consumption data provision
Type(s) of data managed	• 1-minute metering and electrical data (P, Q, U, I) from Smart Meters
Communication method	From smart meter to DSO's DB smart meters provide data via GSM, low voltage meters provide data to the concentrator (collecting data from the smart meters installed at the LV) via PLC (main cases).
Data format	Export of the data from the DB: CSV, XLSX or TXT
Open access	No.
Documentation	One of the possible SWs serving DSO for data collection, management and store: Symbiot - utility management platform.

Leader/responsible	EL
Integration status	Integrated

Table 64: Demo #5 (Slovenia) – Smart Meters

Name	Smart Meters
Brief description	Smart Meters from Slovenia
Pilot(s) and UC(s)	UC SI 1.1 Near real-time measurements with power limit notification UC SI 2.1 Energy-saving tips UC SI 3.1 Advanced analytics of production and consumption data provision
Type(s) of data managed	• 1-minute metering and electrical data (P, Q, U, I) Moj Elektro Portal is managed over Informatika d.o.o. IT company, which is owned by all five DSO in Slovenia. Since Informatika will not implement 1-minute measurements, EL will implement a new ECLIPSE App only for EL (DSO) users, which will access to the new App over Moj Elektro Portal.
Communication method	MQTT
Data format	Export of the data from the App: XLSX

Open access	No
Documentation	Each smart meter producer has its own documentation.
Leader/responsible	EL
Integration status	To be integrated

3.4.5.3. ENERGY SERVICES

Table 65: Demo #5 (Slovenia) – Analyses of the grid user consumption and production data

Name	Analyses of the grid user consumption and production data
Brief description	Modern smart meters can transmit near real-time data, sending measurements every 60 seconds. This capability supports power limit notifications in a new application, which alerts users via SMS or email if their power exceeds a set threshold. With the introduction of a new tariff scheme in October 2024—including five daily periods and monthly peak power charges—users face penalties if their peak usage exceeds declared limits. The application helps users simulate and recalculate network costs based on peak power changes and consumption shifts. By providing timely notifications, the system gives users a chance to reduce power within the 15-minute billing interval, helping them avoid extra charges and manage energy more efficiently.

Inputs	• Close to real time data or • Historical data, both retrieved from the smart meter
Outputs	• Informing the users in case of exceeding the measured 15 min power, in comparison with the predefined threshold. • Detailed load profile of the user, based on 1 min data • Calculation of the future net usage costs, based on a change of the parameters (load or energy shifting across net usage tariffs)
Pilot(s) and UC(s)	UC SI 3.1 Advanced analytics of production and consumption data provision
Status	Under development
Technologies used	Smart meters, DSO's data analytics system, Smart phone applicable services
Documentation	Internal document with detailed specifications of the solution.
Leader/responsible	EL

Table 66: Demo #5 (Slovenia) – Calculation of energy saving potential

Name	Calculation of energy saving potential

Brief description	The user signs in to the Moj Elektro portal using two-step verification of their electronic identity, with unified registration and authentication through the Rekono application. After logging in, the user selects a measurement point. In the newly developed application, the user enters information about their appliances and lifestyle. Based on this input, the application calculates potential energy savings and provides personalized energy-saving tips.
Inputs	• Historical consumption data, • Local production data • additional information about the lifestyle of the user, relevant for the energy savings potential calculation.
Outputs	• Energy saving potential per user • Tips, advices/instructions on how the user can reduce his consumption.
Pilot(s) and UC(s)	UC SI 3.1 Advanced analytics of production and consumption data provision
Status	Under development
Technologies used	Smart meters, DSO's data analytics system, Smart phone applicable services
Documentation	Internal document with detailed specifications of the solution.
Leader/responsible	EL

3.4.5.4. END USER APPLICATIONS

Table 67: Demo #5 (Slovenia) – End User App

Name of the app	End User App
Brief description	The App will be an online analytical tool that allows end users to visualize their consumption data. The aim of the App is, that the users would better manage their energy consumption. For more advanced users and if the smart meter will enable (if not, DSO will replace the existing smart meter with more advanced technology) the App will process also the close to real-time measurements, through webhooks. A webhook is an HTTP request triggered by an event in the source system, which sends data to a target system, often including a useful amount of information. In our case the Webhooks will be automated. App enables users to react on the consumption change, to put more efforts in their consumption reduction and more efficient use. Users will also get tips and personalized recommendations for use the electricity on more efficient way.
Pilot(s) and UC(s)	UC SI 1.1 Near real-time measurements with power limit notification UC SI 2.1 Energy-saving tips UC SI 3.1 Advanced analytics of production and consumption data provision

Expected functionalities	• Support 1-minute and 15-minute end user data • Prediction tool • Personalized recommendations (tips, advice, and actionable steps to save energy) • Tariff-based information • Configuration of power limit thresholds • Notification of power limit exceeded (SMS or email) • Simulation of energy costs based on changes to peak power across different tariffs or shifts in energy consumption
Additional information	Single sign-in approach: our user will still access our App through the Moj Elektro portal and inside of the portal he/she will find the link to the app. Moj Elektro application is also available as a smart phone application. Rekono (or certificated sign) for authentication and authorisation
Leader/responsible	EL
Development status	Under development

3.4.6. DEMO #6 (CYPRUS)

3.4.6.1. PILOT OVERVIEW

Demo #6 Summary: The Cypriot demo targets both residential and commercial energy consumers with the goal of increasing awareness and action around energy consumption, flexibility potential, and digital participation.

The following activities have been planned:

1. **Develop demo UCs (Integration):** TSOC and CINTECH are collaboratively defining UCs that illustrate how Cypriot consumers, can understand and act upon energy insights. These UCs form the blueprint for digital tool design and the overall interaction model.
2. **Develop UI with general tips for optimizing energy consumption and alert status of the power system** (Deployment): ETRA will lead the development of a user-friendly interface designed to deliver clear, energy efficiency guidance. The interface will display consumption trends but also provide actionable advice tailored to different user segments, helping them reduce costs and environmental impact.
3. **Prepare and adapt TSO information systems to process consumer data** (Adaptation): TSOC will upgrade internal systems to securely process and store consumer interaction data, integrate with ECLIPSE's digital infrastructure, and maintain GDPR compliance.

These enhancements support long-term and reliability of the demonstration backend.

4. **Interface release to real grid users – testing phase** (Consumer Engagement): Will be launched for live use by a selected group of real residential and commercial consumers.

5. **Extract conclusions for deliverable** (Deployment): Final analysis of results, including technical performance, user feedback, and lessons learned.

3.4.6.2. DATA SPACES AND DATA SOURCES

Table 68: Demo #6 (Cyprus) – TSOC systems

Name	TSOC systems
Brief description	Data from the Transmission System Operator (TSO) is used to monitor energy pricing and grid conditions. This information enables the system to generate cost-effective consumption recommendations and alerts that reflect the current state of the electricity market and the grid. It forms a key input for applications aimed at reducing energy costs through smart, data-driven decisions.
Pilot(s) and UC(s)	UC CY 1.1: Consumer notifications for Cost-Effective Energy Consumption UC CY 2.1: Environmental awareness notifications for sustainable consumer behaviour

Type(s) of data managed	• Energy pricing • Real-time grid conditions • Electricity generation mix • Grid stability • Renewable energy efforts
Communication method	Web service
Data format	CSV
Open access	No. Data which are available in TSOC's web service are for the entire system, but not in different groups per area/type of consumer.
Documentation	Internal document with detailed specifications
Leader/responsible	TSOC
Integration status	To be integrated

Table 69: Demo #6 (Cyprus) – Consumer data

Name	Consumer data
Brief description	Measurement data, due to the ongoing rollout of smart meters, is currently collected manually on a monthly or bi-monthly basis, depending on availability.

Pilot(s) and UC(s)	UC CY 1.1: Consumer notifications for Cost-Effective Energy Consumption UC CY 2.1: Environmental awareness notifications for sustainable consumer behaviour
Type(s) of data managed	End user metering data
Communication method	Web service
Data format	CSV
Open access	No. Data which are available in TSOC's web service are for the entire system, but not in different groups per area/type of consumer.
Documentation	Internal document with detailed specifications
Leader/responsible	CINTECH, ETRA
Integration status	To be integrated

3.4.6.3. ENERGY SERVICES

Table 70: Demo #6 (Cyprus) – End user notification

Name	**End user notification**

Brief description	The system delivers general, non-customized environmental information to users, with a particular focus on the structure and characteristics of the Cypriot electricity grid and the share of renewable energy sources (RES) in overall energy generation. This information includes insights into energy production patterns, renewable energy availability, and broader economic factors such as energy market prices and grid conditions
Inputs	• Real-time grid data (energy pricing, grid status) • User behaviour insights
Outputs	• Real-time, personalized recommendations for cost-effective energy usage • General, non-customized environmental information • Personalized energy efficiency tips
Pilot(s) and UC(s)	UC CY 1.1: Consumer notifications for Cost-Effective Energy Consumption UC CY 2.1: Environmental awareness notifications for sustainable consumer behaviour UC CY 5.1: Customized energy efficiency tips for sustainable consumer behaviour
Status	Under development
Technologies used	Web service

Documentation	Internal document with detailed specifications
Leader/responsible	CINTECH, ETRA

Table 71: Demo #6 (Cyprus) – Consumption patterns analysis

Name	Consumption patterns analysis
Brief description	The system enables optimized energy management by analysing both economic signals and grid-related conditions. It generates recommendations to help users adjust their consumption patterns and maximize energy savings. Through integration with smart meters, the system also delivers critical alerts and messages, leveraging historical consumption data from previous months to support informed, timely decision-making.
Inputs	• User consumption data
Outputs	• Consumption baseline and patterns
Pilot(s) and UC(s)	UC CY 1.1: Consumer notifications for Cost-Effective Energy Consumption UC CY 5.1: Customized energy efficiency tips for sustainable consumer behaviour

Status	Under development
Technologies used	Webservice
Documentation	Internal document with detailed specifications
Leader/responsible	CINTECH, ETRA

3.4.6.4. END USER APPLICATIONS

Table 72: Demo #6 (Cyprus) – Energy app

Name of the app	**Energy app**
Brief description	ECLIPSE User Application (as described in Section 3.3)
Pilot(s) and UC(s)	UC CY 1.1: Consumer notifications for Cost-Effective Energy Consumption UC CY 2.1: Environmental awareness notifications for sustainable consumer behaviour UC CY 5.1: Customized energy efficiency tips for sustainable consumer behaviour

Expected functionalities	• User registration and preferences • Real-time economic-based recommendations • General environmental information notifications • Personalized energy efficiency tips
Additional information	N/A
Leader/responsible	ETRA, CINTECH, TSOC
Development status	Under development by ETRA (ECLIPSE User Application)

3.4.7. DEMO #7 (GREECE)

3.4.7.1. PILOT OVERVIEW

Demo #7 Summary: The Greek demo focuses on activating residential consumers and relevant stakeholders through user-centric tools and updated IoT infrastructure. The pilot scopes to enhance energy awareness, streamline data aggregation, and provide reliable feedback loops.

The following deployment and integration activities form the technical backbone of the demonstration:

1. **User identification** (Consumer Engagement): The demo begins with identifying and selecting end users for participation. This includes

consumer segmentation based on energy profiles, location, and willingness to engage, forming the user base for testing and feedback.

2. **Validation of installed equipment and repair of any failure** (Adaptation): All previously installed devices (e.g., energy meters or IoT devices) are reviewed for functionality. Non-operational or outdated components are repaired or replaced, ensuring a reliable infrastructure baseline before introducing new functionalities.

3. **Procurement of new IoT equipment for the rest 11 houses** (Adaptation): Any additional smart meters or IoT sensors required for complete coverage are procured. This ensures that all participating users are equipped to provide accurate consumption data and interact with the new digital services.

4. **Installation of IoT equipment** (Deployment): New devices are physically installed at pilot sites, including network configuration, device calibration, and field validation to enable real-time data collection and secure communication.

5. **Test and validate the Installed equipment** (Deployment): After installation, all components will undergo testing to verify performance, accuracy, and system integration.

6. **Test the interface** (Integration): The APP is validated for usability, responsiveness, and correct integration with backend systems.

7. **Online workshop** (Consumer Engagement): A digital co-creation event will be organized involving consumers and stakeholders.

8. **Demo tests** (Deployment): The entire demo ecosystem will be tested in a coordinated environment.

9. **Export and analyse results** (Deployment): Final results, including quantitative usage data and qualitative feedback, are exported and analysed.

3.4.7.2. DATA SPACES AND DATA SOURCES

Table 73: Demo #7 (Greece) – IoT ecosystem

Name	IoT ecosystem
Brief description	Controlling devices for boilers & ACs, environmental sensors that monitor the air quality, PV and EV chargers will be gathered in the final ECLIPSE app.
Pilot(s) and UC(s)	UC GR 1.1: Smart Energy Monitoring for Enhanced Consumer Control UC GR 3.1: Tailored Energy Messages for Consumer Flexibility and Sustainability UC GR 3.2: Personalized Energy Efficiency Tips for Homes with PV and Battery Systems

Type(s) of data managed	• Data from various energy loads, including PV production, HVAC systems, DHW, 1 V2H charger • Not centralized, each type of element connects with their own proprietary app
Communication method	HTTP protocol
Data format	HTTP-based APIs
Open access	No
Documentation	Depending on the vendor of the installed equipment
Leader/responsible	METLEN
Integration status	To be integrated

Table 74: Demo #7 (Greece) – HEDNO systems

Name	**HEDNO systems**
Brief description	System operator infrastructure (SCADA, etc.) providing grid information
Pilot(s) and UC(s)	UC GR 4.1: Risk Management and Operational Resilience in Distribution Systems

Type(s) of data managed	• Grid status and measurements • Fault detection • Network reconfiguration capabilities • Power flow analysis results • Demand curtailment notifications
Communication method	MQTT
Data format	JSON, CSV files, CIM
Open access	NO
Documentation	Internal document with an overview about the production of the grid information signal
Leader/responsible	HEDNO
Integration status	Integrated

Table 75: Demo #7 (Greece) – Simulated consumption data

Name	**Simulated consumption data**
Brief description	Simulated end user data

Pilot(s) and UC(s)	UC GR 4.1: Risk Management and Operational Resilience in Distribution Systems
Type(s) of data managed	• End user consumption
Communication method	E-mail
Data format	CSV files
Open access	NO
Documentation	Not available
Leader/responsible	HEDNO
Integration status	To be integrated

3.4.7.3. ENERGY SERVICES

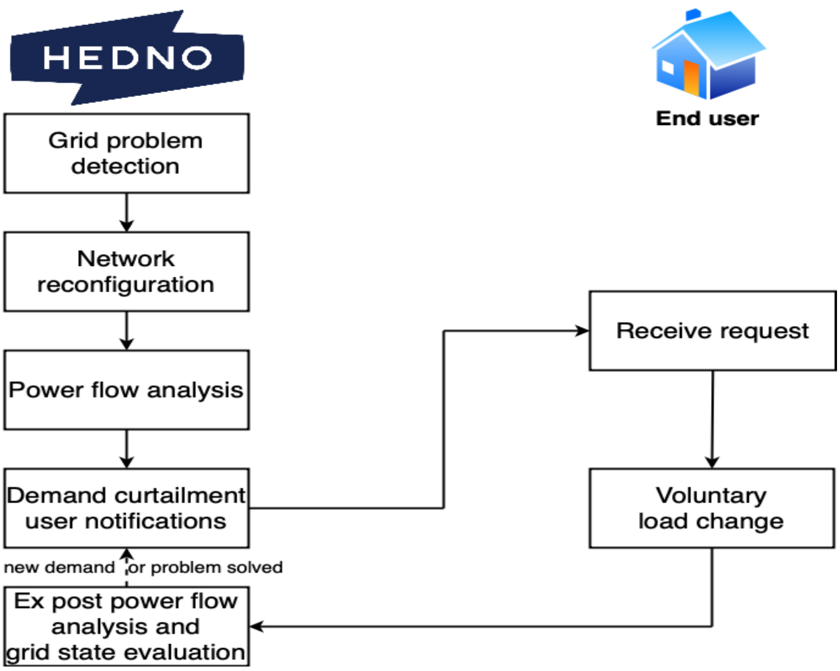
Table 76: Demo #7 (Greece) – End user messaging

Name	End user messaging

Brief description	This service delivers personalized messages based on economic or non-economic incentives. Using IoT data from residents' homes, customized messages that emphasize environmental impact, through the ECLIPSE app, encourage users to reduce their consumption during peak times.
Inputs	• IoT data from resident's homes
Outputs	• Customized messages for energy consumption reduction and energy efficiency guidance
Pilot(s) and UC(s)	UC GR 1.1: Smart Energy Monitoring for Enhanced Consumer Control UC GR 3.1: Tailored Energy Messages for Consumer Flexibility and Sustainability UC GR 3.2: Personalized Energy Efficiency Tips for Homes with PV and Battery Systems
Status	Under development
Technologies used	Smart meters as part of PV installation, controlling devices, controlling devices, environmental sensors
Documentation	No
Leader/responsible	METLEN, ETRA

Table 77: Demo #7 (Greece) – Mitigation of grid problems using end user participation

Name	Mitigation of grid problems using end user participation

Brief description	The loss of operation in a distribution line typically necessitates transferring users to a neighbouring line, which can burden the transformer, forcing it to operate at or near full capacity (95-100%). This state increases the risk of overloading, potentially causing service interruptions and further compromising the reliability of the distribution network. To address this issue, regulating electricity consumption through user participation is being explored as a solution. This approach aims to use the end user as a “lever” to manage demand during critical situations, potentially alleviating strain on the system. Pertinent research focuses on implementing the demand-response mechanisms, designing effective incentives through feedback, and monitoring user response. The study also evaluates the short- and long-term impacts of this strategy on minimizing risks and improving network resilience.  Figure 30: Mitigation of grid problems using end user participation

Inputs	• Grid problem detection (+ analysis pipeline)
Outputs	• Demand curtailment notifications
Pilot(s) and UC(s)	UC GR 4.1: Risk Management and Operational Resilience in Distribution Systems
Status	Simulated, to be extended with user data
Technologies used	PowerFactory, PandaPower, MQTT
Documentation	Not available
Leader/responsible	HEDNO

3.4.7.4. END USER APPLICATIONS

Table 78: Demo #7 (Greece) – End Customer Application (METLEN)

Name of the app	**End Customer Application (for METLEN UCs)**
Brief description	ECLIPSE User Application (as described in Section 3.3)

Pilot(s) and UC(s)	UC GR 1.1: Smart Energy Monitoring for Enhanced Consumer Control UC GR 3.1: Tailored Energy Messages for Consumer Flexibility and Sustainability UC GR 3.2: Personalized Energy Efficiency Tips for Homes with PV and Battery Systems
Expected functionalities	• Integrate data from various energy loads, including PV production, HVAC systems, DHW • Monitor and manage user energy consumption • Personalized messaging based on economic and non-economic benefits and energy efficiency guidance.
Additional information	N/A
Leader/responsible	ETRA, METLEN
Development status	Under development by ETRA (ECLIPSE Energy App)

Table 79: Demo #7 (Greece) – End Customer Application (HEDNO)

Name of the app	End Customer Application (for HEDNO UCs)

Brief description	ECLIPSE user application (as described in Section 3.3)
Pilot(s) and UC(s)	UC GR 4.1: Risk Management and Operational Resilience in Distribution Systems
Expected functionalities	• Manage end user demand during critical situations in the grid • Implementing demand-response mechanisms • Incentives • Monitoring user response
Additional information	N/A
Leader/responsible	ETRA, HEDNO
Development status	Under development by ETRA (ECLIPSE Energy App)

3.4.8. DEMO #8 (SWEDEN)

3.4.8.1. PILOT OVERVIEW

Demo #8 Summary: The Swedish pilot, focuses on aggregating and managing DERs, including 4,500 PV systems, 600 wind turbines, and 1,000 batteries, to support grid stability and offer smart energy services. Operating mainly in Sweden, with possible extensions to Finland and

Denmark, the pilot engages consumers and commercial users in flexibility markets (FCR-D, FFR), and plans to expand into energy arbitrage and peak shaving. Key innovations include integrating weather data for improved forecasting and sending personalized energy insights to users. The pilot also promotes awareness through digital campaigns and community engagement.

The following deployment and integration activities form the technical pillar of the demonstration:

1. **New functionality developed: site status including active service** (Integration): The ECLIPSE platform is enhanced to allow users to view the current operational status of their site, including real-time load and export values, empowering consumers to better understand their energy behaviour and respond to flexibility opportunities.

2. **New Functionality: Visualize Savings and Revenue** (Integration): Consumers are provided with dynamic visualisations showing both historical and real-time savings from their participation in flexibility services, along with revenue from energy exports. This strengthens user motivation by making economic benefits clear and actionable.

3. **New Release and Testing by Partners and Selected Customers** (Deployment): The updated platform is released in a controlled environment for testing by project partners and a select group of end-users. Feedback is collected regarding usability, accuracy, and

engagement potential, essential for refining features before full rollout.

3.4.8.2. DATA SPACES AND DATA SOURCES

Table 80: Demo #8 (Sweden) – Nordpool

Name	Nordpool
Brief description	Spot prices in Sweden
Pilot(s) and UC(s)	UC SW 1.1: Extended flexibility services for households UC SW 1.2: Service stacking for revenue optimisation UC SW 3.1: Introduce behind-the-meter services UC SW 4.1: Combine flex-services with behind-the-meter services
Type(s) of data managed	• Spot prices
Communication method	HTTP
Data format	JSON
Open access	Registered users
Documentation	Nordpool.se

Leader/responsible	CWATT
Integration status	Integrated

Table 81: Demo #8 (Sweden) – Metering and IoT system

Name	Metering and IoT system
Brief description	Integration of IoT Gateways, batteries with Battery Management System, solar inverters, Smart meters, and sensors.
Pilot(s) and UC(s)	UC SW 1.1: Extended flexibility services for households UC SW 1.2: Service stacking for revenue optimisation UC SW 3.1: Introduce behind-the-meter services UC SW 4.1: Combine flex-services with behind-the-meter services
Type(s) of data managed	• End user consumption
Communication method	Modbus, HTTP
Data format	JSON
Open access	No
Documentation	www.checkwatt.se

Leader/responsible	CWATT
Integration status	Integrated

3.4.8.3. ENERGY SERVICES

Table 82: Demo #8 (Sweden) – VPP aggregation service

Name	VPP aggregation service
Brief description	It aggregates 15k household batteries into a single resource that can be offered to the grid for balancing purposes or local flexibility markets
Inputs	• Metering and IoT data
Outputs	• Support services to TSO (e.g., FFR, FCR-N, FCR-D up and FCR-D down) • Local flexibility to DSO
Pilot(s) and UC(s)	UC SW 1.1: Extended flexibility services for households UC SW 1.2: Service stacking for revenue optimisation UC SW 3.1: Introduce behind-the-meter services UC SW 4.1: Combine flex-services with behind-the-meter services
Status	Developed

Technologies used	VPP aggregation, database, AI
Documentation	www.checkwatt.se
Leader/responsible	CWATT

Table 83: Demo #8 (Sweden) – Energy arbitrage

Name	**Energy arbitrage**
Brief description	Energy arbitrage for consumers that are already providing flexibility services to the TSO.
Inputs	• Spot prices
Outputs	• Analyse and calculate price peaks and bottoms • VPP schedule in CM10 for charging/discharging battery
Pilot(s) and UC(s)	UC SW 3.1: Introduce behind-the-meter services UC SW 4.1: Combine flex-services with behind-the-meter services
Status	Under development
Technologies used	AI, machine learning
Documentation	www.checkwatt.se

Leader/responsible	CWATT

3.4.8.4. END USER APPLICATIONS

Table 84: Demo #8 (Sweden) – End user app

Name of the app	End user app
Brief description	App for visualising production and consumption of energy. Visualisation of revenues from different sources like flexibility markets and services like energy arbitrage.
Pilot(s) and UC(s)	UC SW 1.1: Extended flexibility services for households UC SW 1.2: Service stacking for revenue optimisation
Expected functionalities	• Asset monitoring • Flexibility services participation • Daily revenue calculation
Additional information	N/A
Leader/responsible	CWATT
Development status	Developed

3.4.9. DEMO #9 (PORTUGAL)

3.4.9.1. PILOT OVERVIEW

Demo #9 Summary: The Portuguese case, focuses on involving low-voltage participants in Porto, Braga, and Guarda to support grid flexibility and efficiency. E-REDES will leverage smart meter data and use Balcão Digital app to send users flexibility services requests and offer them insights into activation results and consumption, while R&D NESTER supplies grid simulations requesting grid needs and facilitates TSO-DSO interaction. The pilot aims to test demand response UCs, including automated user signals for grid needs and emergency alerts. Broader public engagement is encouraged through awareness campaigns, app features, local workshops, and the dissemination of information in media channels to promote active consumer participation in Portugal's energy transition.

The following deployment and integration activities form the technical pillar of the demonstration:

1. **Develop demo UCs & interface *(Integration)*:** Define the functional blueprint of the demonstration, outlining user journeys, data flows, and digital interaction points. An interface mock-up is designed to showcase how consumers will participate in energy ancillary markets and visualise their flexibility insights.
2. **Link DSO with TSO** (Integration): A technical link between the DSO (E-REDES) and TSO systems is established to test data sharing, coordination mechanisms, and market interactions. This

interoperability is a key innovation of the demo, contributing to pan-European coordination objectives.

3. **Adapt current app** (Adaptation): Existing customer-facing application is updated to reflect new functionalities related to flexibility monitoring, participation in energy ancillary markets, and feedback to build on already familiar interfaces and reduce the learning curve.
4. **Test app and interoperability** (Integration): Following interface development and system linking, a round of joint testing is performed to validate the app's usability and ensure seamless operation between end consumer, DSO and Market Simulator.
5. **Contact customers from previous projects** (Consumer Engagement): Customers who participated in earlier initiatives (e.g., interoperability pilots or demand-response programs) are approached for participation in this demonstration, scoping to develop a knowledgeable and pre-qualified user base, accelerating onboarding and testing.
6. **Presentation to interested customers** (Consumer Engagement): Public or targeted sessions (demonstrations, briefings) are organised to present the goals of the pilot, explain its benefits, demonstrate how the application works, and encourage informed participation.
7. **Sign contract with customers** (Consumer Engagement): Formal engagement agreements are signed with pilot participants, scoping to define the purpose of participation, data permissions, the

participants' duties and rights, and the nature of any incentives and benefits.

8. **Tests in field** (Deployment): Testing is carried out under operational conditions, involving real user data, interface interactions, and cross-system coordination, to validate robustness, data integrity, and responsiveness in a real-world context.
9. **Extract conclusions for deliverable** (Deployment): The pilot team collects and analyses performance data, user feedback, and technical insights to set conclusions for the relevant deliverables.

3.4.9.2. DATA SPACES AND DATA SOURCES

Table 85: Demo #9 (Portugal) – Databricks Platform

Name	Databricks Platform
Brief description	Storage of consumer and market data.
Pilot(s) and UC(s)	UC PT 1.1 Economically-Driven Consumer Flexibility Participation in System Services UC PT 2.1 Non-Economically-Driven Consumer Flexibility Participation in System Services UC PT 4.1 Flexibility Services under Extreme Conditions

Type(s) of data managed	• Market bids and offers • Consumer information and historical data • Consumer baseline • Consumer flexibility data
Communication method	HTTPS method
Data format	JSON
Open access	No
Documentation	[Azure Databricks documentation | Azure Docs]
Leader/responsible	E-REDES
Integration status	Integrated. Development of interface between Databricks Platform and Balcão Digital app is underway.

Table 86: Demo #9 (Portugal) – TSO communication

Name	**TSO communication**
Brief description	Communication with Portuguese TSO

Pilot(s) and UC(s)	UC PT 1.1 Economically-Driven Consumer Flexibility Participation in System Services UC PT 2.1 Non-Economically-Driven Consumer Flexibility Participation in System Services UC PT 4.1 Flexibility Services under Extreme Conditions
Type(s) of data managed	• Extreme conditions warning • Requests for participation in tertiary reserve markets • Bids for participation in tertiary reserve markets • List of selected consumers to be activated for flexibility provision
Communication method	HTTPS
Data format	Standardized XML Format
Open access	No
Documentation	Reserve Bid document Activation document Emergency Condition document (Activation Document schema will be modified as per the requirement by combining coded elements defined in the ENTSO-E EDI Library).
Leader/responsible	R&D Nester

Integration status	Development underway

Table 87: Demo #9 (Portugal) – ENTSO-E Transparency Platform

Name	**ENTSO-E Transparency Platform**
Brief description	European electricity system data
Pilot(s) and UC(s)	UC PT 1.1 Economically-Driven Consumer Flexibility Participation in System Services UC PT 2.1 Non-Economically-Driven Consumer Flexibility Participation in System Services UC PT 4.1 Flexibility Services under Extreme Conditions
Type(s) of data managed	• Total country load and generation • Cross-border physical flows • Energy prices • Outages • Balancing market bids
Communication method	HTTPS (Rest API)
Data format	JSON
Open access	Yes

Documentation	ENTSO-E Transparency Platform
Leader/responsible	R&D Nester
Integration status	Integrated

3.4.9.3. ENERGY SERVICES

Table 88: Demo #9 (Portugal) – End user messaging

Name	End user messaging
Brief description	The end user receives flexibility services messages through the app.
Inputs	• TSO bid request • Grid status information
Outputs	• End user request for flexibility • Emergency signals for extreme events in the grid • Accepted/rejected flexibility messages • Notification before activation • Flexibility data availability messages

Pilot(s) and UC(s)	UC PT 1.1 Economically-Driven Consumer Flexibility Participation in System Services UC PT 2.1 Non-Economically-Driven Consumer Flexibility Participation in System Services UC PT 4.1 Flexibility Services under Extreme Conditions
Status	Under development
Technologies used	Notifications/push notifications
Documentation	Not available
Leader/responsible	E-REDES

Table 89: Demo #9 (Portugal) – Market Simulator

Name	**Market Simulator**
Brief description	Tool for simulation of the reserve energy market in which users can test their bidding strategies for a given market time unit and receive market results
Inputs	• Flexibility bids
Outputs	• Bid flexibility activation or rejection

Pilot(s) and UC(s)	UC PT 1.1 Economically-Driven Consumer Flexibility Participation in System Services UC PT 2.1 Non-Economically-Driven Consumer Flexibility Participation in System Services
Status	Under development
Technologies used	Cloud service
Documentation	Not available
Leader/responsible	R&D Nester

Table 90: Demo #9 (Portugal) – Flexibility calculation

Name	**Flexibility calculation**
Brief description	Calculation of provided flexibility and, when applicable, green credits or price on the Databricks Platform.
Inputs	• Consumer information and historical data
Outputs	• Baseline, flexibility, price or green credits

Pilot(s) and UC(s)	UC PT 1.1 Economically-Driven Consumer Flexibility Participation in System Services UC PT 2.1 Non-Economically-Driven Consumer Flexibility Participation in System Services UC PT 4.1 Flexibility Services under Extreme Conditions
Status	Under development
Technologies used	Python, JSON, HTTPS method
Documentation	Not available
Leader/responsible	E-REDES

Table 91: Demo #9 (Portugal) – E-REDES Operational Planning System

Name	E-REDES Operational Planning System
Brief description	Assessment of whether the activation of consumer flexibility will lead to grid restrictions. Selection/filtering of consumers that will provide flexibility (based on operational parameters).
Inputs	• Databricks platform data • Grid topology • Grid data • Consumer information

Outputs	• Grid analysis (load flow) • Filtered list of consumers
Pilot(s) and UC(s)	UC PT 1.1 Economically-Driven Consumer Flexibility Participation in System Services UC PT 2.1 Non-Economically-Driven Consumer Flexibility Participation in System Services
Status	Developed
Technologies used	D-Plan – Commercial Program
Documentation	DPLAN
Leader/responsible	E-REDES

3.4.9.4. END USER APPLICATIONS

Table 92: Demo #9 (Portugal) – Balcão Digital App

Name of the app	Balcão Digital App
Brief description	Prosumer active participation in energy markets based on economic or non-economic incentives.

Pilot(s) and UC(s)	UC PT 1.1 Economically-Driven Consumer Flexibility Participation in System Services UC PT 2.1 Non-Economically-Driven Consumer Flexibility Participation in System Services UC PT 4.1 Flexibility Services under Extreme Conditions
Expected functionalities	• Monitor energy consumption • Calculation of consumer provided flexibility • Receive TSO request for bids or participation (via DSO) • Publication of emergency signals for extreme events in the grid • Submission of available flexibility (based on household appliances) to the market
Additional information	N/A
Leader/responsible	E-REDES
Development status	Developed. Implementation of new functionality for the project is underway.

3.4.10. DEMO #10 (CROATIA)

3.4.10.1. PILOT OVERVIEW

Demo #10 Summary: It aims to enhance demand response capabilities by engaging large industrial consumers, aggregators, and producers across the country. While HOPS has no consumer-facing app, it uses SCADA and accounting systems to monitor TSO-connected assets and flexible DSO assets. The pilot will explore HLUCs focused on economic and non-economic incentives for flexibility, as well as alerts for extreme grid events. HOPS plans public calls and campaigns to onboard voluntary participants and expand flexibility services, emphasizing the importance of financial incentives to motivate Stakeholders' engagement.

The following deployment and integration activities form the technical pillar of the demonstration:

1. **Develop demo UCs & interface** (Integration): Definition of specific consumer scenarios that guide the structure and user logic of the demo, including conceptualisation and initial design of the platform interface through which consumers can access insights and interact with flexibility-related information.

2. **Test app** (Integration): Functional testing of the developed app ensures usability, responsiveness, and accuracy of real-time and historical data displays.

3. **Contact target customers** (Consumer Engagement): HOPS identifies and initiates outreach to a relevant consumer group, possibly leveraging existing utility or TSO customer databases, populating the pilot with test users' representative of the broader residential sector.

4. **Presentation to target audience** (Consumer Engagement): Informational sessions are organised to explain goals, benefits, and technical aspects of the demonstration.

5. **Obtaining the consents** (Consumer Engagement): Formal consent is collected from participating consumers, covering GDPR requirements, data sharing, monitoring scope, and conditions of participation, ensuring legal clarity and transparency for all involved stakeholders.

6. **DSO involvement** (Integration): Coordination with the national DSO is ensured for access to metering data, customer profiles, or grid interaction requirements. This supports a seamless backend integration of consumer data and may inform real-time flexibility simulations.

7. **Adapt app** (Integration): Adjustments are made to the application based on early testing and stakeholder feedback.

8. **Demo test** (Deployment): Conducted with the participating consumers, where all systems, interface, data connections, algorithms, are evaluated in operational conditions, enabling validation of user behaviour and system performance.

9. **Conclusions** (Deployment): Post-demo synthesis is carried out, analysing both qualitative and quantitative results. Key insights, consumer feedback, and technical learnings are documented for inclusion in project deliverables and to support recommendations for wider implementation.

3.4.10.2. DATA SPACES AND DATA SOURCES

Table 93: Demo #10 (Croatia) – HOPS systems

Name	HOPS systems
Brief description	Data from the TSO to track energy pricing and grid conditions

Pilot(s) and UC(s)	UC HR 1.1: Tailored Notifications for Cost-Effective Energy Consumption UC HR 1.2: Sandbox Tariff Program for Active Energy Engagement UC HR 2.1: RES Share Notification for Sustainable Energy Decisions UC HR 4.1: Sandbox for Voluntary Participation in Energy Balancing Market UC HR 4.2: Optimizing Energy Consumption for Grid Stability via Demand Response UC HR 4.3: Emergency Grid Overload Alerts UC HR 4.4: Severe Weather and Emergency Response Alerts UC HR 4.5: Blackout and Critical Emergency Alerts UC HR 5.1: Environmental Awareness Notifications (General Information)
Type(s) of data managed	• Energy pricing • Real-time grid conditions • Grid demand and renewables share • TSO requests during periods of grid imbalance • Extreme weather conditions and expected grid impact
Communication method	HTTPS, Rest API

Data format	JSON, XML
Open access	No
Documentation	To be completed
Leader/responsible	HOPS
Integration status	Integrated

Table 94: Demo #10 (Croatia) – DSO systems

Name	DSO systems
Brief description	Data from DSO for metering purposes in sandbox use cases

Pilot(s) and UC(s)	UC HR 1.1: Tailored Notifications for Cost-Effective Energy Consumption UC HR 1.2: Sandbox Tariff Program for Active Energy Engagement UC HR 3.1: RES Share Notification for Sustainable Energy Decisions UC HR 4.1: Sandbox for Voluntary Participation in Energy Balancing Market UC HR 4.2: Optimizing Energy Consumption for Grid Stability via Demand Response UC HR 4.3: Emergency Grid Overload Alerts UC HR 4.4: Severe Weather and Emergency Response Alerts UC HR 4.5: Blackout and Critical Emergency Alerts UC HR 5.1: Environmental Awareness Notifications (General Information)
Type(s) of data managed	• End user metering data
Communication method	IEC 62056; VPN
Data format	XML; CIM

Open access	No; HOPS and Croatian DSO have access
Documentation	To be completed
Leader/responsible	HOPS
Integration status	Integrated

Table 95: Demo #10 (Croatia) – Smart meters

Name	**Smart meters**
Brief description	Energy consumption data from end users that is tracked by the Energy app to assess the modification on user behaviour based on: • energy savings recommendations, • participation in demand response campaigns, • participation in tariff sandboxes, and • load shifting due to extreme grid conditions.

Pilot(s) and UC(s)	UC HR 1.1: Tailored Notifications for Cost-Effective Energy Consumption UC HR 1.2: Sandbox Tariff Program for Active Energy Engagement UC HR 3.1: RES Share Notification for Sustainable Energy Decisions UC HR 4.1: Sandbox for Voluntary Participation in Energy Balancing Market UC HR 4.2: Optimizing Energy Consumption for Grid Stability via Demand Response UC HR 4.3: Emergency Grid Overload Alerts UC HR 4.4: Severe Weather and Emergency Response Alerts UC HR 4.5: Blackout and Critical Emergency Alerts UC HR 5.1: Environmental Awareness Notifications (General Information)
Type(s) of data managed	• Energy consumption
Communication method	IEC 61970 / IEC 61968; SCADA protocols
Data format	XML;CIM

Open access	No; HOPS and Croatian DSO have access
Documentation	To be completed
Leader/responsible	HOPS
Integration status	Integrated as part of DSO systems

3.4.10.3. ENERGY SERVICES

Table 96: Demo #10 (Croatia) – Notifications to consumers and intermediaries

Name	Notifications to consumers and intermediaries

Brief description	Real-time, personalized notifications to consumers and intermediaries (such as energy managers or suppliers) based on economic factors, with the goal of optimizing energy consumption and reducing costs. Consumers may be notified to shift their energy consumption to off-peak hours when energy prices are lower, or they may receive alerts about upcoming price surges that encourage immediate reduction in energy usage. Data analysis in the context of user consumption patterns to generate personalized insights, focusing on when energy consumption is most cost-effective. Users are notified through a mobile or web app about optimal times for energy usage, leveraging real-time grid and pricing data. Notifying app users when the share of renewable energy generation exceeds a predefined threshold for awareness of clean energy utilization and consumption alignment. The notifications will primarily highlight facts about the Croatian electricity generation mix, grid stability, and renewable energy efforts, giving users a clearer understanding of their local energy ecosystem. Additionally, users will be informed about major milestones, environmental statistics, and the benefits of energy conservation specifically related to the Croatian grid.

Inputs	• Real-time grid data (energy pricing, grid demand, renewables share, grid status) • TSO requests during periods of grid imbalance • Extreme weather conditions and expected grid impact
Outputs	• Tailored notifications based on economic factors • Notifications with time-specific advice (tariff sandbox) • Notifications when share of RES generation exceeds threshold • General, non-customized environmental information to users for education and awareness • Real-time alerts to modify end users' and BSPs' consumption habits to alleviate stress on the grid • Real-time alerts to reduce or shift end users' consumption to stabilize the grid (DR campaigns) • Real-time emergency alerts during grid overloads

Pilot(s) and UC(s)	UC HR 1.1: Tailored Notifications for Cost-Effective Energy Consumption UC HR 1.2: Sandbox Tariff Program for Active Energy Engagement UC HR 2.1: RES Share Notification for Sustainable Energy Decisions UC HR 4.1: Sandbox for Voluntary Participation in Energy Balancing Market UC HR 4.2: Optimizing Energy Consumption for Grid Stability via Demand Response UC HR 4.3: Emergency Grid Overload Alerts UC HR 4.4: Severe Weather and Emergency Response Alerts UC HR 4.5: Blackout and Critical Emergency Alerts UC HR 5.1: Environmental Awareness Notifications (General Information)
Status	Under development
Technologies used	Push notifications, SMS, or emails depending on the severity (UC HR 4.3, UC HR 4.4, UC HR 4.5)
Documentation	To be completed
Leader/responsible	HOPS

3.4.10.4.END USER APPLICATIONS

Table 97: Demo #10 (Croatia) – End User App

Name of the app	End User App
Brief description	The mobile app will provide notifications to the end users. A gamification feature within the app will be designed to encourage users to adopt more sustainable energy consumption and production habits, as well as avoiding grid overloads.
Pilot(s) and UC(s)	UC HR 1.1: Tailored Notifications for Cost-Effective Energy Consumption UC HR 1.2: Sandbox Tariff Program for Active Energy Engagement UC HR 2.1: RES Share Notification for Sustainable Energy Decisions UC HR 4.1: Sandbox for Voluntary Participation in Energy Balancing Market UC HR 4.2: Optimizing Energy Consumption for Grid Stability via Demand Response UC HR 4.3: Emergency Grid Overload Alerts UC HR 4.4: Severe Weather and Emergency Response Alerts UC HR 4.5: Blackout and Critical Emergency Alerts UC HR 5.1: Environmental Awareness Notifications (General Information)

Expected functionalities	• User registration and notification preferences • User enrolment in demand response campaigns and tariff sandboxes (and possibility to opt out) • Real-time, personalized notifications to consumers based on economic factors • Notifications about optimal times for energy usage (as part of tariff sandbox) • Collection of user demand response feedback (load shifting) • Calculation of cost reduction • Calculation of rewards for user participation in campaigns • Notifications when share of RES generation exceeds threshold • General, non-customized environmental information • Participation in energy balancing market • Demand response for grid stress alleviation • Real-time emergency alerts during grid overload • Alerts on severe weather conditions • Blackout alerts
Additional information	Possibility of expanding the app functionalities

Leader/responsible	HOPS
Development status	Under development

3.4.11. DEMO #11 (CZECH REPUBLIC)

3.4.11.1. PILOT OVERVIEW

Demo #11 Summary: It focuses on enhancing its existing customer app "Proud" to promote active energy management among 3.8 million supply points. The pilot will introduce new features like personalised tariff recommendation based on home appliances, energy tips for consumption reduction, gamified CO_2 savings challenges, detailed user energy profiling, and emergency alerts. It also aims to improve data sharing with large customers via APIs. These updates support use cases around economic and non-economic flexibility incentives, energy efficiency, and grid resilience, building on CEZ's existing awareness campaigns and digital tools.

The following deployment and integration activities form the technical pillar of the demonstration:

1. **Develop demo UCs and interface** (Integration): Definition of targeted UCs, including interaction logic and expected user benefits. These use cases form the foundation for app improvements and guide

consumer engagement strategies. A draft interface is also envisioned to visualise energy usage and present feedback.

2. **Adapt current app** (Adaptation): The existing application used by CEZ Distribuce customers is modified to reflect the UCs defined previously, including updates to layout, information architecture, and potential integration of new features (e.g., energy-saving tips or feedback channels).
3. **Obtaining consent for demo participation** (Consumer Engagement): Prior to pilot launch, consumers are contacted, and consent is secured, ensuring full compliance with GDPR and ethical standards.
4. **Test app** (Integration): The adapted app undergoes functional and usability testing with a sample group of consumers. Feedback is gathered regarding clarity, accessibility, and usefulness of the features. Bugs or UX challenges are addressed before full deployment.
5. **Extract conclusions for deliverable** (Deployment): Findings from the app test and consumer feedback are synthesised into a final assessment, which includes technical and engagement-related conclusions, and inform the project reporting for improvements and replicability plans.

3.4.11.2. DATA SPACES AND DATA SOURCES

Table 98: Demo #11 (Czech Republic) – ERP system (SAP)

Name	ERP system (SAP)
Brief description	The system reads user data, such as business partner details, EAN, fuse amperage, address, and consumption and production readings, directly from SAP. The integration utilizes SAP NetWeaver as a foundation, while the WSO2 gateway facilitates secure and efficient data transfer between the various components. The data is then hosted on AWS, ensuring robust scalability and security. End-user devices, such as smartphones, serve as the primary interface, allowing users to interact with the application effortlessly. Through this setup, users can not only access real-time data but also file requests for services like self-readings, unsealing, cable insulation, tree cutting, and other technical requests, thus enhancing the overall user experience and operational efficiency.

Pilot(s) and UC(s)	UC CZ 1.1: Personalised tariff recommendation based on home appliances UC CZ 2.1: Energy goals for sustainable energy use UC CZ 3.1: Consumption prediction UC CZ 3.2: Advanced presentation of measured data UC CZ 3.3: Consulting related to measured data UC CZ 4.1: Notifications of power outages caused by natural disasters UC CZ 5.2: Energy tips for consumption reduction
Type(s) of data managed	• Energy consumption and production data
Communication method	SAP NetWeaver services (WSO2 gateway facilitates secure and efficient data transfer between the various components)
Data format	JSON
Open access	No
Documentation	Yes (internal)
Leader/responsible	CEZ
Integration status	Integrated

3.4.11.3. ENERGY SERVICES

Table 99: Demo #11 (Czech Republic) – Tariff recommendation functionality

Name	Tariff recommendation functionality
Brief description	The algorithm instantly selects the most advantageous distribution tariff based on the chosen appliances. The user will be notified of the option to change their distribution tariff, along with information about potential savings in distribution fees.
Inputs	• User appliances
Outputs	• Best suitable tariff
Pilot(s) and UC(s)	UC CZ 1.1: Personalised tariff recommendation based on home appliances
Status	Under development
Technologies used	Open-source libraries (e.g. React Native)
Documentation	Yes (internal)
Leader/responsible	CEZ

Table 100: Demo #11 (Czech Republic) – Challenge management functionality

Name	Challenge management functionality
Brief description	Gamification feature within the mobile application designed to encourage users to adopt more sustainable energy consumption and production habits. The system provides users with various challenges that promote energy efficiency, increased renewable energy production, and more frequent application usage for monitoring and optimization.
Inputs	• Consumers energy consumption and generation data • User appliances
Outputs	• Consumers education • Rewards such as Achievements Badges
Pilot(s) and UC(s)	UC CZ 2.1: Energy goals for sustainable energy use
Status	Under development
Technologies used	Open-source libraries (e.g. React Native)
Documentation	Yes (internal)
Leader/responsible	CEZ

Table 101: Demo #11 (Czech Republic) – Content management system

Name	Energy consumption management system
Brief description	An advisory system that provides customers with personalized energy-saving tips and predictions based on measured energy consumption and production data. The system delivers automated notifications regarding daily fluctuations, medium-term, and long-term trends, allowing users to optimize their energy consumption.
Inputs	• Energy consumption and production data • Energy consumption prediction
Outputs	• Energy-saving tips
Pilot(s) and UC(s)	UC CZ 3.2: Advanced presentation of measured data UC CZ 3.3: Consulting related to measured data UC CZ 5.2: Energy tips for consumption reduction
Status	Under development
Technologies used	Open-source libraries (e.g. React Native)
Documentation	Yes (internal)
Leader/responsible	CEZ

Table 102: Demo #11 (Czech Republic) – Outage management system

Name	Outage management system
Brief description	In case of extreme weather events, the service notifies customers about serious grid issues based on DSO/TSO information directly in the app via push notification (failures and planned outages are already implemented).
Inputs	• DSO/TSO information
Outputs	• User notification
Pilot(s) and UC(s)	UC CZ 4.1: Notifications of power outages caused by natural disasters
Status	Under development
Technologies used	DMS outage management module called SRI
Documentation	Yes (internal)
Leader/responsible	CEZ

Table 103: Demo #11 (Czech Republic) – Consumption prediction system

Name	Consumption prediction system
Brief description	Energy consumption predictions based on historical data, meteorological conditions, and other relevant factors. Predictions are provided for different time horizons (day, week, month, year) and are visualized in the form of line charts.
Inputs	• Historical data • Prediction models
Outputs	• Predicted consumption data
Pilot(s) and UC(s)	UC CZ 3.1: Consumption prediction
Status	Developed, to be adapted
Technologies used	Open-source libraries (e.g. React Native)
Documentation	Yes (internal)
Leader/responsible	CEZ

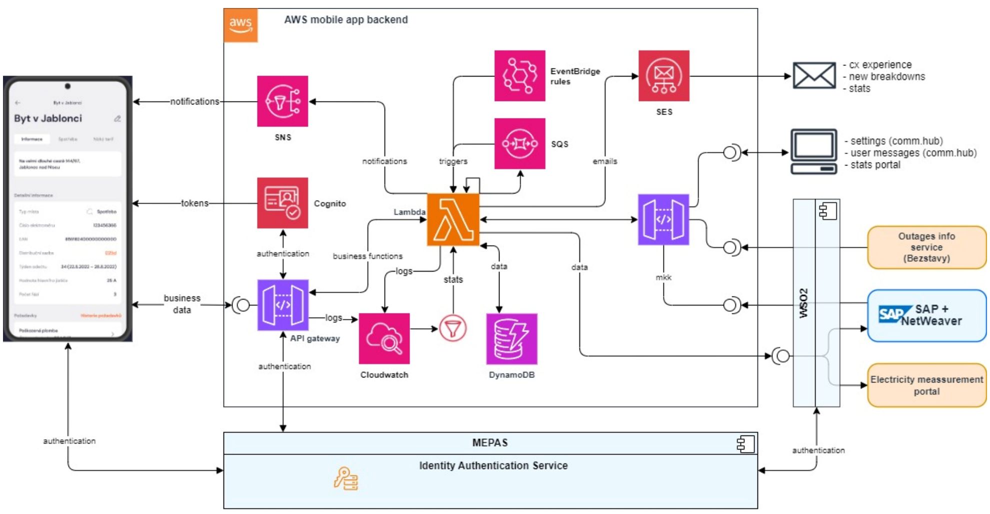
3.4.11.4. END USER APPLICATIONS

Table 104: Demo #11 (Czech Republic) – Proud App

Name of the app	Proud App
Brief description	Current Customer mobile app called “Proud” (Czech word for electric current) contains multiple functionalities such as: • visualization of consumption data, • outages and failures, • self-readings of the meter, • notifications, • reporting, • contacts, • generator connection online check.

Pilot(s) and UC(s)	UC CZ 1.1: Personalised tariff recommendation based on home appliances UC CZ 2.1: Energy goals for sustainable energy use UC CZ 3.1: Consumption prediction UC CZ 3.2: Advanced presentation of measured data UC CZ 3.3: Consulting related to measured data UC CZ 4.1: Notifications of power outages caused by natural disasters UC CZ 5.2: Energy tips for consumption reduction

Expected functionalities	• Tariff recommendation
	  ○ Definition of home appliances and their parameters
	  ○ Definition of household parameters (basic dimensions, size, type of the apartment, house, etc.)
	  ○ Analysis of most suitable tariff based on appliances
	  ○ Message for optional tariff change
	  ○ Message to update appliances regularly
	• Gamification to encourage users to adopt more sustainable energy consumption and production habits
	• Energy saving tips
	  ○ Messages with recommendations
	  ○ Tracking/calculation of energy savings
	  ○ Mark tips as completed and monitor progress
	• Disaster notifications
	  ○ Notifications about the occurrence, progress, and termination of a fault at user consumption point
	  ○ Message inbox + push notifications
	  ○ Management of notification preferences
	• Consumption prediction

	o Selection of time horizon o Consumption prediction in chart form o Alert message when predicted consumption exceeds a defined threshold • Advanced presentation of measured data (consumption and production) o Track historical data o Identify trends • Personalized energy-saving tips and predictions based on measured energy consumption and production data
Additional information	 Figure 31: Proud App (and underlying architecture) More information: www.cezdistribuce.cz/cs/proud
Leader/responsible	CEZ

Development status	The app itself is developed. Functionalities under ECLIPSE project will be added in planned releases.

3.4.12. DEMO #12 (POLAND)

3.4.12.1. PILOT OVERVIEW

Demo #12 Summary: The Polish pilot focuses on enhancing customer engagement through upgrades to its “eMeter” app, targeting prosumers and energy communities in regions like Silesia and Malopolska. The Polish pilot scopes to address voltage stability challenges caused by high PV penetration by encouraging flexible consumption through non-economic incentives and delivering energy efficiency tips. The pilot leader will also explore clear, plain-language communication and expand awareness through ongoing campaigns and events, supporting smarter, more responsive energy use among its customers.

The following deployment and integration activities form the technical pillar of the demonstration:

1. **Develop demo UCs** (Integration): Initial scoping of the pilot defines realistic and value-driven scenarios for residential consumers, with the UCs mapped to digital interactions and data flows to guide platform development and ensure regulatory alignment.
2. **Link DSO app with TSO guidelines** (Integration): The application architecture is updated to integrate flexibility and monitoring

principles set by the TSO. This includes data exchange protocols, user engagement logic, and energy monitoring functionalities to reflect national regulatory goals.

3. **Adapt current app** (Adaptation): TAURON updates its consumer-facing mobile or web application to reflect new use cases and TSO coordination rules, involving UI design, back-end data management, and improved transparency for end users.
4. **Test app** (Integration): A controlled pilot test is conducted to validate the updated application. Functionality, accessibility, and user experience are assessed in terms of both technical performance and end-user understanding.
5. **User identification** (Consumer Engagement): Target customers are selected based on demographic or energy consumption criteria. This separation ensures a meaningful sample group, balancing digital literacy, energy profiles, and geographic spread.
6. **Presentation to the customer** (Consumer Engagement): Pilot objectives, functionalities, and benefits are communicated to identified users via digital or in-person channels. These presentations serve to build trust, promote transparency, and facilitate onboarding.
7. **Obtaining consent for demo** (Consumer Engagement): Formal consent is collected to comply with GDPR and secure user permission for participation and data usage.

8. **Demo tests** (Deployment): The integrated system is tested in real-world conditions. Participants interact with the updated app, and data from these sessions are captured to evaluate engagement, technical performance, and satisfaction.

9. **Extract conclusions for deliverable** (Deployment): A structured evaluation of demo outcomes is carried out, with technical findings, consumer feedback, and participation data analysed and summarised for reporting and future replication planning.

3.4.12.2. DATA SPACES AND DATA SOURCES

Table 105: Demo #12 (Poland) – Tariff information

Name	Tariff information
Brief description	TAURON Dystrybucja SA has introduced a new innovative grid tariff. G14dynamic is a four-zone tariff where the duration of the time zones throughout the day - ‘recommended use’, ‘normal use’, ‘recommended saving’, and ‘required curtailment’ - varies according to the situation in the national energy system (e.g., forecast production from wind and solar provided by TSO). Customers given this information can easily determine when their electricity usage is most or least environmentally friendly and grid-friendly. Those who can flexibly manage their energy consumption can thus reduce the amount of their distribution service bills.

Pilot(s) and UC(s)	UC PL 4.1: Demand side flexibility based on non-economic incentives in specific network situations
Type(s) of data managed	• G14dynamic tariff information (zones, times, prices) ○ In the first step, the information will come from the national electricity system level (TSO). In the future, this information may be site-specific and come from the DSO systems.
Communication method	HTTPS
Data format	XML
Open access	No
Documentation	Internal
Leader/responsible	TAURON
Integration status	Integrated

Table 106: Demo #12 (Poland) – PSE systems

Name	**PSE systems**
Brief description	PSE (Polish TSO) forecasts the operation of the national electricity system by settings the energy peak hours for the next day.

Pilot(s) and UC(s)	UC PL 4.1: Demand side flexibility based on non-economic incentives in specific network situations
Type(s) of data managed	• Energy peak hours at national level • Grid conditions
Communication method	HTTPS
Data format	XML
Open access	No
Documentation	Yes (internal)
Leader/responsible	TAURON
Integration status	To be integrated

3.4.12.3. ENERGY SERVICES

Table 107: Demo #12 (Poland) – End user messaging

Name	**End user messaging**

Brief description	Consumers receive general information, tips, and guidance on energy efficiency practices, especially related to PVs (recommended inverter settings, obligation to report the increase in installation power capacity to the DSO, etc.) . This will include also promoting efficient behaviours, the use of more energy-efficient appliances, insulation options, self-generation of energy, storage solutions, etc. The app provides push information to motivate the customer to: 1. shift their energy consumption voluntarily without direct economic benefits. The need could be based on current network situation (e.g., voltage levels in the local grid). 2. limiting the shutdown of PVs caused by voltage situation by increasing the self-consumption in certain time periods. 3. change the PV technical parameters at your DSO. We've many cases, where our customer when rebuilding their PV installation, increases the PV power without informing the DSO.
Inputs	• Grid conditions • PV curtailment forecast
Outputs	• Customized messages to users for consumption shifting, self-consumption increase, or information update • General information, tips, and guidance on energy efficiency practices, especially related to PVs

Pilot(s) and UC(s)	UC PL 4.1: Demand side flexibility based on non-economic incentives in specific network situations UC PL 5.1: Messages with general tips and guidance for energy efficiency and awareness rising
Status	Under development
Technologies used	Real-time smart meters readouts for the local consumption, grid conditions, push notifications with personalised messages
Documentation	Internal
Leader/responsible	TAURON

3.4.12.4. END USER APPLICATIONS

Table 108: Demo #12 (Poland) – eLicznik App

Name of the app	eLicznik App
Brief description	Creating additional customer contact scheme enabling quick reaction for multiple scenarios for better grid functioning using aggregated dispersed scale effect.

Pilot(s) and UC(s)	UC PL 4.1: Demand side flexibility based on non-economic incentives in specific network situations UC PL 5.1: Messages with general tips and guidance for energy efficiency and awareness rising

Expected functionalities	• Provide information about the G14dynamic tariff (four tariff time zones: 'recommended use', 'normal use', 'recommended saving', and 'required curtailment')
	  o In the first step, the information will come from the national electricity system level (TSO). In the future, this information may be site-specific and come from the DSO systems.
	• Push notifications for:
	  o Energy consumption shifting based on grid conditions
	  o PV curtailment limitation by increasing self-consumption
	  o Update PV technical parameters to the DSO
	• General information, tips, and guidance on energy efficiency practices, especially related to PVs

Additional information	Additional functionalities may be developed during pilot demo based on gained experience.

Leader/responsible	TAURON
Development status	Developed, under testing

3.4.13. DEMO #13 (ROMANIA)

3.4.13.1. PILOT OVERVIEW

Demo #13 Summary: The Romanian pilot, focuses on testing energy monitoring, flexibility, and efficiency solutions within its student campus and Faculty of Energy Engineering. Using infrastructure from previous H2020 projects, the pilot integrates smart metering, PV systems, storage, heat pumps, and EV charging into a living lab environment. A new app based on CERF will deliver personalized and general messages to promote energy-conscious behaviours and CO_2 reduction. The university also plans to leverage its academic and industry networks for awareness campaigns and knowledge sharing.

The following deployment and integration activities form the technical pillar of the demonstration:

1. **Define pilot scope and integration architecture:** Map the functional components (smart meters, PV systems, storage, heat pumps, EV chargers) into a unified living lab infrastructure, ensuring compatibility and interoperability.

2. **Set up and validate infrastructure:** Activate and test the operation of pre-existing systems from H2020 projects to ensure readiness for real-time monitoring and control within the university campus.

3. **Customize CERF-based mobile application:** Develop and adapt the app interface and backend to deliver both personalized and general messages aimed at promoting energy-conscious behaviours and CO_2 footprint reduction.

4. **Deploy real-life testing in campus environment:** Enable system interaction by students and staff, capturing real-time energy usage patterns, user engagement, and behavioural response to app recommendations.

5. **Conduct engagement and awareness activities:** Organize workshops, seminars, or lectures within the university to raise awareness of energy efficiency topics and introduce the app to the target user groups.

6. **Leverage academic and industry networks:** Promote the pilot and disseminate findings through university channels, partner organizations, and stakeholder events to support knowledge sharing and replication.

3.4.13.2. DATA SPACES AND DATA SOURCES

Table 109: Demo #13 (Romania) – FEE Network Monitoring System

Name	Faculty of Energy Engineering (FEE) Network Monitoring System
Brief description	Voltages in specific grid nodes and power exchange on the MV/LV transformers are monitored and potential violation of limits is analysed and messages are sent to preserve grid health and avoid extreme grid situations.
Pilot(s) and UC(s)	UC RO 4.1 Help in preserving grid health (HGH) UC RO 4.2 Help in avoiding extreme grid situations (HAEGS)
Type(s) of data managed	• Overloads on transformers or general fuse and possible near-term disconnection signal ○ Part real, part simulated
Communication method	MQTT, Modbus
Data format	JSON, Modbus
Open access	Yes
Documentation	To be developed
Leader/responsible	NUSTPB

Integration status	Integrated

Table 110: Demo #13 (Romania) – FEE Advanced Metering System

Name	**Faculty of Energy Engineering (FEE) Advanced Metering System**
Brief description	Production of the PV systems of the FEE is monitored and used as input for advising necessary consumption during excess of energy. This is seen as consumption following the PV production.
Pilot(s) and UC(s)	UC RO 2.1 Follow_the_Sun UC RO 5.1 Recommendation on Energy Management for Residential Buildings
Type(s) of data managed	• End user consumption (metering data) aggregated at different levels - individual rooms, shared spaces and whole buildings • RES production
Communication method	MQTT, Modbus
Data format	JSON, Modbus
Open access	Yes

Documentation	To be developed
Leader/responsible	NUSTPB
Integration status	Integrated, to be extended

3.4.13.3. ENERGY SERVICES

Table 111: Demo #13 (Romania) – End user messaging

Name	End user messaging
Brief description	Personalized messages to consumers to enhance CO_2 footprint.
Inputs	• Potential CO_2 footprint reduction by synchronizing shiftable loads with the high-RES production periods • Identified behaviours and characteristics of consumption profiles over a longer period of time including study periods, exam session or holiday periods
Outputs	• Personalized messages
Pilot(s) and UC(s)	UC RO 2.1 Follow_the_Sun UC RO 5.1 Recommendation on Energy Management for Residential Buildings

Status	Under development
Technologies used	Realtime smart meters readouts for the local PV production and for local consumption, web interface, eventually push notifications, to be later clarified. Based on knowing the list of important loads, especially heat pumps and EV charger available in the Faculty monitored areas, and using 1 minute data (consumption and PV production) and NILM technology, specific messages can be sent to heat-pumps and EV charger users (with known characteristics), such that they can engage these loads by better “following the sun” strategy.
Documentation	To be developed
Leader/responsible	NUSTPB

Table 112: Demo #13 (Romania) – Energy optimization calculation

Name	**Energy optimization calculation**
Brief description	Analysis over user consumption in order to improve CO_2 footprint in combination with identified behaviours and characteristics of consumption profiles.
Inputs	• End user consumption

Outputs	• Potential CO_2 footprint reduction by synchronizing shiftable loads with the high-RES production periods • Identified behaviours and characteristics of consumption profiles over a longer period of time including study periods, exam session or holiday periods
Pilot(s) and UC(s)	UC RO 2.1 Follow_the_Sun UC RO 5.1 Recommendation on Energy Management for Residential Buildings
Status	Under development
Technologies used	Realtime smart meters readouts for the local consumption, web interface, eventually push notifications, to be later clarified.
Documentation	To be developed
Leader/responsible	NUSTPB

Table 113: Demo #13 (Romania) – FEE load flow twin

Name	**Faculty of Energy Engineering (FEE) load flow twin**
Brief description	Simulation of extreme grid situations by combining real grid data with simulated situations calculated in quasi real-time by using OpenDSS Load Flow application.

Inputs	• Grid data
Outputs	• Load flow calculation
Pilot(s) and UC(s)	UC RO 4.2 Help in avoiding extreme grid situations (HAEGS)
Status	Developed
Technologies used	Quasi-real time simulation of a grid with OpenDSS load-flow application combined with similitude factors and real time smart meters readouts for the PV production and local consumption, details to be later clarified
Documentation	To be developed
Leader/responsible	NUSTPB

3.4.13.4. END USER APPLICATIONS

Table 114: Demo #13 (Romania) – Customer App

Name of the app	**Customer App**
Brief description	Mobile app that provides personalized messages to consumers regarding their potential CO_2 footprint reduction for increasing efficiency, for avoiding grid overloads and for coping with extreme grid situation

Pilot(s) and UC(s)	UC RO 2.1 Follow_the_Sun UC RO 5.1 Recommendation on Energy Management for Residential Buildings UC RO 4.1 Help in preserving grid health (HGH) UC RO 4.2 Help in avoiding extreme grid situations (HAEGS)
Expected functionalities	• User information and settings, • Personalized messages and tips • CO_2 footprint calculation • Consumption reduction programs advises to avoid grid overload • Reports on extreme grid situations for user behaviour modification (alerts and monitoring of the situation)
Additional information	SCADA-like application to be adapted for end user access
Leader/responsible	NUSTPB
Development status	Partially developed, to be extended and improved

3.4.14. HORIZONTAL COMPONENTS

Table 115: EDDIE Data Space

Name	EDDIE Data Space
Brief description	The Clean Energy Package establishes customer rights to access energy data and share it with chosen eligible parties, fostering the development of new data-driven services within and beyond the energy sector. However, the lack of standardized procedures across the EU poses a significant obstacle to the implementation of such solutions. Currently, actors adhere to national practices, hindering interoperability and limiting growth opportunities. To address this issue, EDDIE introduces a decentralized, distributed, open-source Data Space. The European Distributed Data Infrastructure for Energy (EDDIE) significantly reduces data integration costs, allowing energy service companies to operate and compete seamlessly in a unified European market. Additionally, an Administrative Interface for In-house Data Access (AIIDA) ensures secure and reliable access to valuable real-time data based on customer consent.
Type(s) of data managed	• Historical validated energy consumption data • Near-real time end user data

Interoperability standards	n/a
Open access	Yes
General documentation	Project Website: https://eddie.energy Architecture Documentation: https://eddie-web.projekte.fh-hagenberg.at/architecture/ Framework Documentation: https://eddie-web.projekte.fh-hagenberg.at/framework
API documentation	https://eddie-web.projekte.fh-hagenberg.at/javadoc/
Leader/responsible	FHOOE
Pilot(s) and UC(s)	UC AT 1.1: Personalised messages for consumer flexibility based on economic benefits UC AT 2.1: Personalised messages focusing on non-economic incentives for benefits of the system UC AT 3.1: Energy efficiency potential at aggregated level UC AT 5.1: Energy Awareness and Education UC FR 3.2 Increasing flexibility potential of building's distributed energy resources (DER) through explicit and implicit demand response (France, Estonia)

Integration status	Ongoing

Table 116: Non-Intrusive Load Monitoring (NILM)

Name	Non-Intrusive Load Monitoring (NILM)
Brief description	The Non-Intrusive Load Monitoring (NILM) component provides meaningful energy related insights by analysing total power consumption and disaggregating it into individual appliance usage using variables like active power, reactive power, current, and voltage. Unsupervised and semi-supervised methods like k-means clustering have been explored, offering a trade-off between reduced accuracy and the benefit of not requiring intrusive monitoring. In this way, real-time appliance power consumption can be predicted, creating generalized models that can be applied to any household with metering data.
Inputs	• 1-minute end-user total active power (and reactive power, optionally) • List of household appliances and characteristics • (Optional) 1-minute household appliances active (and reactive) power (for evaluation purposes)
Outputs	• 1-minute active power values disaggregated into household loads

Pilot(s) and UC(s)	UC CY 1.1: Consumer notifications for Cost-Effective Energy Consumption UC RO 2.1 Follow_the_Sun UC SI 2.1 Energy-saving tips UC SI 3.1 Advanced analytics of production and consumption data provision
Status	Developed, to be adapted
Technologies used	MLflow (AI models), XGBOOST (training), FastAPI, MeteorJS
Documentation	Opentunity D4.1 [28]
Leader/responsible	ETRA

4. CONCLUSIONS

This deliverable analyses and describes the development plan and first implementation of the ECLIPSE Common European Reference Model (CERF) in the 13 pilots of the project.

Firstly, the open-source development plan of the ECLIPSE CERF includes a roadmap for its creation, the identification of software foundations to ease its implementation, and the analyses of the governance schemes used in the most widespread data spaces, and the stakeholder's engagement plan to be implemented in each pilot.

The **roadmap for the creation of the CERF** provides a detailed step-by-step strategy to set up the reference framework, from definition and design, to development, validation, and maintenance. Each step is fittingly linked to the scope of the ECLIPSE project that is taking care of the task.

Three interoperable connectors from other projects and open-source organisations were identified as potential pieces of software that would facilitate the integration of the CERF in specific scenarios. The **Generic Adapter (GA)** from InterConnect project provides semantic interoperability for legacy components (devices and APIs) using Service Specific Adapters (SSAs) and Knowledge Interactions (KIs) that eventually implement graph pattern triples that can be queried using SPARQL. The **EDDIE connector** from the OneNet/EDDIE projects provides building blocks for CIM-based data exchange between customers, devices, data applications, and eligible parties. Finally, the **Eclipse Semantic Modelling Framework (ESMF)** from the Eclipse Foundation models aspects of digital twins in order to easily generate APIs and UIs based on semantic information.

The **governance scheme** of two of the main European Data Spaces initiatives (**IDSA** and **Gaia-X**) and two Horizon Europe projects (**Enershare** and **SYNERGIES**) are analysed in order to identify their functional layers and incentive mechanisms. All studied cases are structured in (or can be mapped to) four layers: technical, semantic, organizational, and legal. Intra- and Inter-Data Space Governance schemes address the internal structure of a single Data Space and the interoperability across them respectively. Finally, the three main types of incentive mechanisms are data-by-currency, data-by-data, and data altruism, although Gaia-X does not explicitly define any.

The tailored **stakeholder's engagement plan** for each of the 13 demo pilots include the list of identified stakeholders, planned engagement activities and strategies, and risk considerations and mitigation measures. Digital tools and personalized engagement are the primary tools in most cases, which showcase the importance of the CERF for their implementation, integration, and alignment.

Secondly, the first version of the implementation of the ECLIPSE CERF is described. A brief introduction of the current version of the **CERF architecture** and identified data exchange interfaces is provided (the final version is currently under development as part of WP3). For some of these key interfaces, **generic APIs** are being created in order to both facilitate and standardize the communication among the components of the CERF. These interfaces include the **DSO/utilities API**, the Home Energy Management System **(HEMS) API**, and the **Energy app API**.

The overall development plan for each demo site is presented, together with the identified elements of the CERF architecture that will be either developed or integrated as part of the demonstration. These elements are grouped into three categories: **data spaces/data sources** (34 in total across all pilots), **energy services** (33), and **end user applications** (13). This last category includes the **ECLIPSE user application**, which is being developed as part of the project and will be tested and evaluated in several pilots.

By the submission of this deliverable, the process of implementation of the ECLIPSE CERF is currently ongoing, both in horizontal level (with the definition of the architecture and the development of the generic APIs and user application) and in vertical level (with the alignment and integration of the existing components in each pilot and the development of specific new ones). This implementation will continue for the next months, running in parallel with the testing and evaluation of the different elements and the start of the demonstration activities. This second phase of the implementation, together with any deviation from the information included in this document, will be reported in D4.2 “ECLIPSE CERF for Energy Saving applications_V2”, due M24.

5. REFERENCES AND ACRONYMS

5.1. REFERENCES

[1] "Interconnect Project - Homepage," [Online]. Available: https://interconnectproject.eu/. [Accessed 11 07 2025].

[2] "Homepage - OneNet Project," [Online]. Available: https://www.onenet-project.eu/. [Accessed 11 07 2025].

[3] "Home - EDDIE - European distributed data infrastructure for energy," [Online]. Available: https://eddie.energy/. [Accessed 10 07 2025].

[4] "About the Eclipse Foundation | The Eclipse Foundation," [Online]. Available: https://www.eclipse.org/org/. [Accessed 10 07 2025].

[5] I. D. S. e. V., "International Data Spaces Association," International Data Spaces Association e. V., [Online]. Available: https://internationaldataspaces.org. [Accessed 3 June 2025].

[6] "Home - Gaia-X: A Federated Secure Data Infrastructure," [Online]. Available: https://gaia-x.eu/. [Accessed 31 07 2025].

[7] "Enershare | The Energy Data Space for Europe," [Online]. Available: https://enershare.eu/. [Accessed 29 07 2025].

[8] "Home - energydataspaces," [Online]. Available: https://energydataspaces.eu/. [Accessed 29 07 2025].

[9] "IEC 62325-351:2016 | IEC," [Online]. Available: https://webstore.iec.ch/en/publication/25128. [Accessed 10 07 2025].

[10] "IEC 62746-10-1:2018 | IEC," [Online]. Available: https://webstore.iec.ch/en/publication/26267. [Accessed 10 07 2025].

[11] "Apache License 2.0 | Software Package Data Exchange (SPDX)," [Online]. Available: https://spdx.org/licenses/Apache-2.0. [Accessed 10 07 2025].

[12] "Mozilla Public License 2.0 | Software Package Data Exchange (SPDX)," [Online]. Available: https://spdx.org/licenses/MPL-2.0. [Accessed 10 07 2025].

[13] S. Steinbuss, Governances for Data Space Instances – Aspects and Roles for the IDS Stakeholders, International Data Spaces Association, 2021.

[14] "The European Interoperability Framework," 30 May 2025. [Online]. Available: https://interoperable-europe.ec.europa.eu/collection/nifo-national-interoperability-framework-observatory/european-interoperability-framework-detail.

[15] L. Nagel and D. Lycklama, Design Principles for Data Spaces - Position Paper (Version 1.0), International Data Spaces Association, 2021.

[16] N. Fulgêncio, A. Gouveia, G. Glória, A. Egorov, U. Kripser, R. J. Bessa, G. Bodea, S. Jimenez, G. Cvet and R. Martins, European Common Energy Data Space Framework Enabling Data Sharing-Driven Across — and Beyond — Energy Services, ENERSHARE, 2023.

[17] Gaia-x Architecture Document - 22.04 Release, 2022.

[18] "W3C Recommendations - 3.3 Presentations," [Online]. Available: https://www.w3.org/TR/vc-data-model/#presentations. [Accessed 2 June 2025].

[19] "JSON-LD 1.1," [Online]. Available: https://www.w3.org/TR/json-ld11/. [Accessed 2 June 2025].

[20] "W3C Recommendation - 3.2 Credentials," [Online]. Available: https://www.w3.org/TR/vc-data-model/#credentials. [Accessed 2 June 2025].

[21] A. Dognini, A. Monti, A. Kung, A. Medela, C. Joglekar, C. Schaffer, D. Stampatori, D. Jimenez, E. Maqueda, F. Coelho, F. Mancel, F. Sedighi, G. Hartner, G. Lipari, J. Valino, J. Jimeno Huarte, L. Guitart, L. Schmitt, L. Carreras and Berk, Blueprint of the Common European Energy Data Space, Munich: Interoperability Network for the Energy Transition, 2024.

[22] S. Jimenez, Interoperability Framework in Energy Data Spaces, Dortmund: International Data Spaces Association, 2023.

[23] T. S. M. E. D. U. C. I. ICCS, D2.1: 1st version of SYNERGIES Requirements and Detailed Architecture Design, SYNERGIES, 2023.

[24] "European Data Governance Act (DGA) Regulation (EU) 2022/868," European Commission, European Union, 2022.

[25] "European Artificial Intelligence Act (AIA) Regulation (EU) 2024/1689," European Commission, European Union, 2024.

[26] "InterConnect Public / DSOi · GitLab," [Online]. Available: https://gitlab.inesctec.pt/interconnect-public/dsoi. [Accessed 11 07 2025].

[27] "InterConnect - D4.2 Technical Specification of DSO Interface," [Online]. Available: https://interconnectproject.eu/wp-content/uploads/2023/05/InterConnect_D4.2.pdf. [Accessed 11 07 2025].

[28] Opentunity consortium, "D4.1 Enhanced, user-friendly EMS for residential/building flexibility discovery and delivery," 2025.

[29] "IDS-RAM_4_0," [Online]. Available: https://github.com/International-Data-Spaces-Association/IDS-RAM_4_0. [Accessed 30 May 2025].

5.2. ACRONYMS

Table 117 List of acronyms

Acronym	Description
AAS	Asset Administration Shell
AI	Artificial Intelligence
AIIDA	Administrative Interface for In-house Data Access
API	Application Programming Interface
App	Application
AWS	Amazon Web Services
B2B	Business-to-business
BMS	Battery Management System
BMS	Building Management System
CA	Certificate Authority
CEEDS	Common European Energy Data Space
CERF	Common European Reference Model
CIM	Common Information Model

CLI	Command Line Interface
ComU	Commercial user
COSEM	Companion Specification for Energy Metering
CPO	Charge Point Operator
CSV	Comma-separated values
DAPS	Dynamic Attribute Provisioning Service
DB	Database
DC	Direct current
DER	Distributed Energy Resources
DERA	Data Exchange Reference Architecture
DHW	Domestic Hot Water
DID	Decentralized Identifiers
DLMS	Device Language Message Specification
DMS	Distribution Management System
DNP3	Distributed Network Protocol, version 3
DR	Demand Response

DSMR	Dutch Smart Meter Requirements
DSO	Distribution System Operator
DSOi	DSO Interface (from InterConnect project)
D4G	Digital4Grids
E	Employee
EAN	European (or International) Article Number
EC	Energy Community
ECo	Energy Community operator
EDDIE	European Distributed Data Infrastructure for Energy
EDI	Electronic Data Interchange library (from ENTSO-E)
EDS	Energy Data Space
EIF	European Interoperability Framework
EMA	Energy market actors
EMS	Energy Management System
ENTSO-E	European Network of Transmission System Operators for Electricity
ESCO	Energy Service Company

ESMF	Eclipse Semantic Modelling Framework
ESMP	European Style Market Profile
EU	European Union
EV	Electric Vehicle
FCR-D	Frequency Containment Reserve – Disturbance
FCR-N	Frequency Containment Reserve – Normal
FFR	Fast Frequency Response
FSP	Flexibility Service Provider
FV	Fleet Vehicle
GA	Generic Adapter (from InterConnect project)
GDPR	General Data Protection Regulation
GSM	Global System for Mobile Communications
HDLC	High-Level Data Link Control
HEMS	Home Energy Management System
HLUC	High-Level Use Case
HV	High Voltage

HVAC	Heating, Ventilation, and Air Conditioning
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
H2020	Horizon 2020
I	Current
IAM	Identity and Access Management
IBAN	International Bank Account Number
ICCP	Inter Control Center Protocol
ID	Identifier
IDS	International Data Spaces
IDSA	International Data Spaces Association
IDSCP	IDS Communication Protocol
IEC	International Electrotechnical Commission
IFC	Industry Foundation Classes
IoT	Internet of Things
JSON	JavaScript Object Notation

JSON-LD	JSON for Linked Data
KI	Knowledge Interactions
kW	Kilowatt
kWh	Kilowatt-hour
k3s	Lightweight Kubernetes
k8s	Kubernetes
LED	Light-emitting diode
LV	Low Voltage
M-Bus	Meter-Bus
MEP	Message Exchange Pattern
ML	Machine Learning
Modbus RTU	Modbus Remote Terminal Unit
MPL	Mozilla Public License
MQTT	Message Queuing Telemetry Transport
MV	Medium Voltage
MW	Megawatt

N/A	Not available
NGO	Non-Governmental Organization
NILM	Non-Intrusive Load Monitoring
NRT	Near real-time
OCPP	Open Charge Point Protocol
OEO	Open Energy Ontology
OPC	Open Platform Communications Foundation
OPC-UA	OPC Unified Architecture
OPC-XML-DA	OPC XML-Data Access
OpenADR	Open Automated Demand Response
OpenDSS	Open electric power Distribution System Simulator
P	Active power
ParIS	IDS Participant Information Service
PLC	Programmable Logic Controller
PV	Photovoltaics
Q	Reactive power

Q&A	Questions and answers
RDF	Resource Description Framework
ResC	Residential consumer
ResP	Residential prosumer
RES	Renewable Energy Source
RESp	RES prosumer
REST	Representational State Transfer
RJ	Registered jack
ROI	Return of Investment
SAMM	Semantic Aspect Meta Model
SAREF	Smart Applications REFerence
SCADA	Supervisory Control and Data Acquisition
SDK	Software Development Kit
SGAM	Smart energy Grid Architecture Model
SHACL	Shapes Constraint Language

SIORD	Sistema de Información de las Redes de Distribución (Distribution System Operator Information System)
SLA	Service Level Agreement
SME	Small and medium businesses
SMS	Short Message Service
SO	System Operator
SPARQL	SPARQL Protocol and RDF Query Language
SSA	Service-Specific Adapter
SSI	Self-Sovereign Identity
SW	Software
TCP/IP	Transmission Control Protocol over Internet Protocol
ToU	Time-of-Use pricing
TSO	Transmission System Operator
TXT	Text file
U	Voltage
UC	Use case

UI	User interface
UX	User experience
URL	Uniform Resource Locator
VC	Verifiable Credentials
VHD	Validated historical data
VPN	Virtual Private Network
VPN IPsec	VPN set up using Internet Protocol Security
V2G	Vehicle-to-grid
V2H	Vehicle-to-home
VPP	Virtual Power Plant
wMBUS	Wireless Meter-Bus
WP	Work Package
WS	Web service
W3C	World Wide Web Consortium
XLSX	Office Open XML Workbook
XML	Extensible Markup Language

Thank You

If you have any questions, please get in touch with us.

www.eclipse-digital.eu
info@eclipse-digital.eu
@eclipseproject
@Eclipse_Europe
@EclipseEUProject