



Design and Development of ECLIPSE CERF and APIs

Turning the architectural blueprint into a functional reality for 13 European pilots

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Abstract

This brochure presents the transition of ECLIPSE DIGITAL project from architectural specifications to tangible implementation. As the project's technical engine room, Work Package 4 (WP4) is constructing the open-source infrastructure that brings the Common European Reference Framework (CERF) to life.

Key technical milestones include the deployment of standardized API gateways, bridging DSO, HEMS, Data Sources, and User App interfaces, and the integration of powerful software connectors like the Generic Adapter, EDDIE, and ESMF to ensure universal interoperability.

A central innovation is the ECLIPSE User Application, which features Near Real-Time (NRT) visibility and NILM (Non-Intrusive Load Monitoring) technology for appliance-level monitoring. This framework is now being validated across 13 demo sites in 17 EU countries, testing 33 innovative energy services to build a resilient and consumer-centric European energy space.

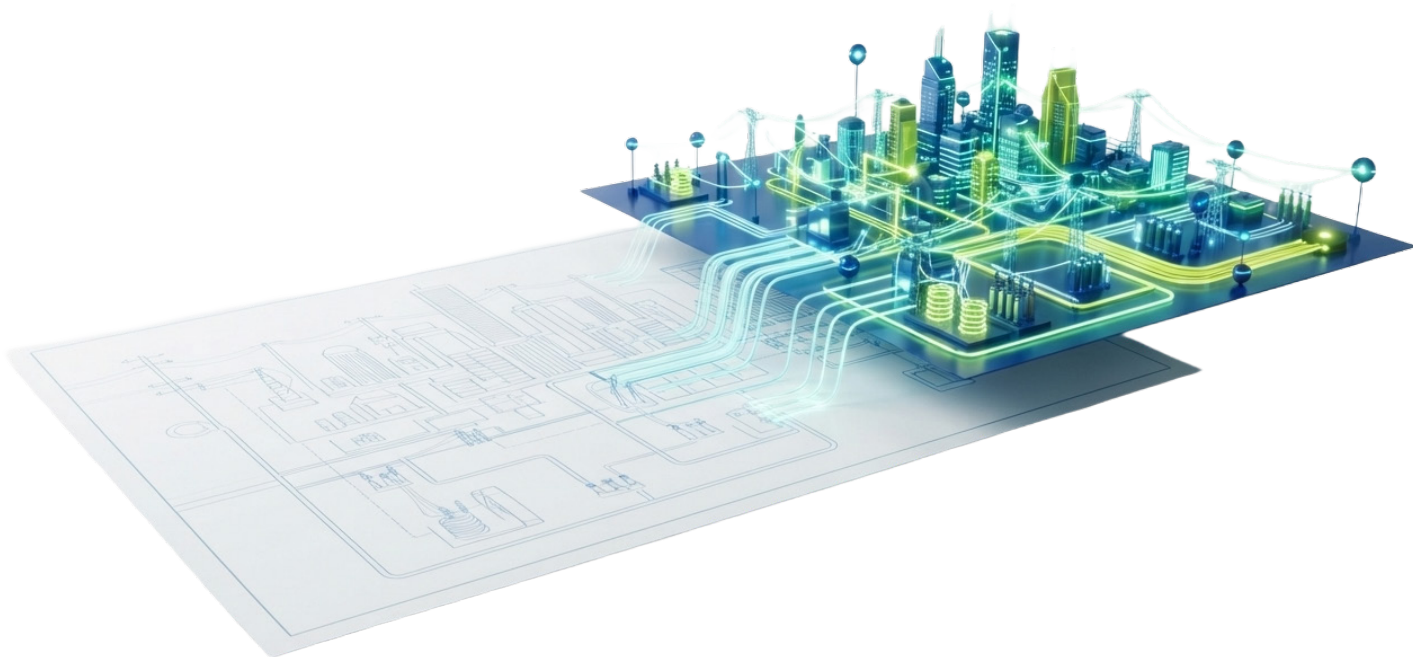
Building the Digital Reality: Implementing CERF and Standardized APIs

Work Package 4 (WP4) serves as the **technical engine room where the ECLIPSE DIGITAL project transitions from vision to execution**. While previous phases identified consumer requirements, WP4 is dedicated to the actual **construction of the Common European Reference Framework (CERF)**. This is not just a theoretical design; it is a functional, open-source infrastructure that follows a strict Development Plan to homogenize energy applications across 17 EU countries.

By eliminating proprietary silos, we are creating a **sovereign energy data ecosystem** where data flows securely between citizens, grid operators, and service providers. WP4 provides the essential "connective tissue" of the European energy market, offering a replicable model that leverages Artificial Intelligence and Machine Learning to empower every household to participate actively in the green transition.

Primary Implementation Pillars:

- **Standardized API Deployment:** Implementing generic interfaces for DSOs, TSOs, HEMS, and User Apps to facilitate universal data exchange.
- **Open-Source Rulebook:** Establishing a common set of standards to ensure energy saving applications are "future-proofed" and cross-border compatible.
- **AI-Driven Analytics:** Integrating advanced algorithms to provide near real-time feedback and actionable energy insights to the end-user.



The 9-Step Journey: From Laboratory to Real-World Impact

The creation of the CERF is a structured, multi-stage evolution designed to ensure technical stability, data security, and legislative compliance. This roadmap encompasses the entire **lifecycle of digital innovation**:



Standardizing the Language of Energy: Software Pillars and APIs

To achieve true semantic interoperability, WP4 leverages three powerhouse software connectors that allow diverse systems to "speak" the same language.

- **Generic Adapter (GA)** [1]: Derived from the InterConnect project [2], it bridges legacy devices and traditional APIs into a semantic environment using Knowledge Interactions (KIs).
- **EDDIE Connector** [3]: Provides the building blocks for data exchange based on the global CIM (Common Information Model) standard, ensuring that prosumers and aggregators can coordinate in real-time.
- **Eclipse ESMF** [4]: A cutting-edge framework that models "Digital Twins" of energy assets, automatically generating the necessary APIs and user interfaces based on semantic information.



We have identified and deployed four critical gateways to standardize data exchange:



- **DSO API**: Manages user registration, grid-zone data information, metering data access and flexibility transactions between operators and aggregators.
- **TSO API**: Provides demand and generation information, grid status, spot prices, and general recommendations.
- **HEMS API**: Connects to Home Energy Management Systems for automated device registration, measurements and control.

- **Energy App API** : The essential link for mobile applications to manage user profiles and access measurements.
- **Data Sources API**: Harmonizes smart meter and historical data to provide the "ground truth" for billing and analytics. It utilizes MQTT for efficient, near-real-time telemetry from household assets to the CERF.

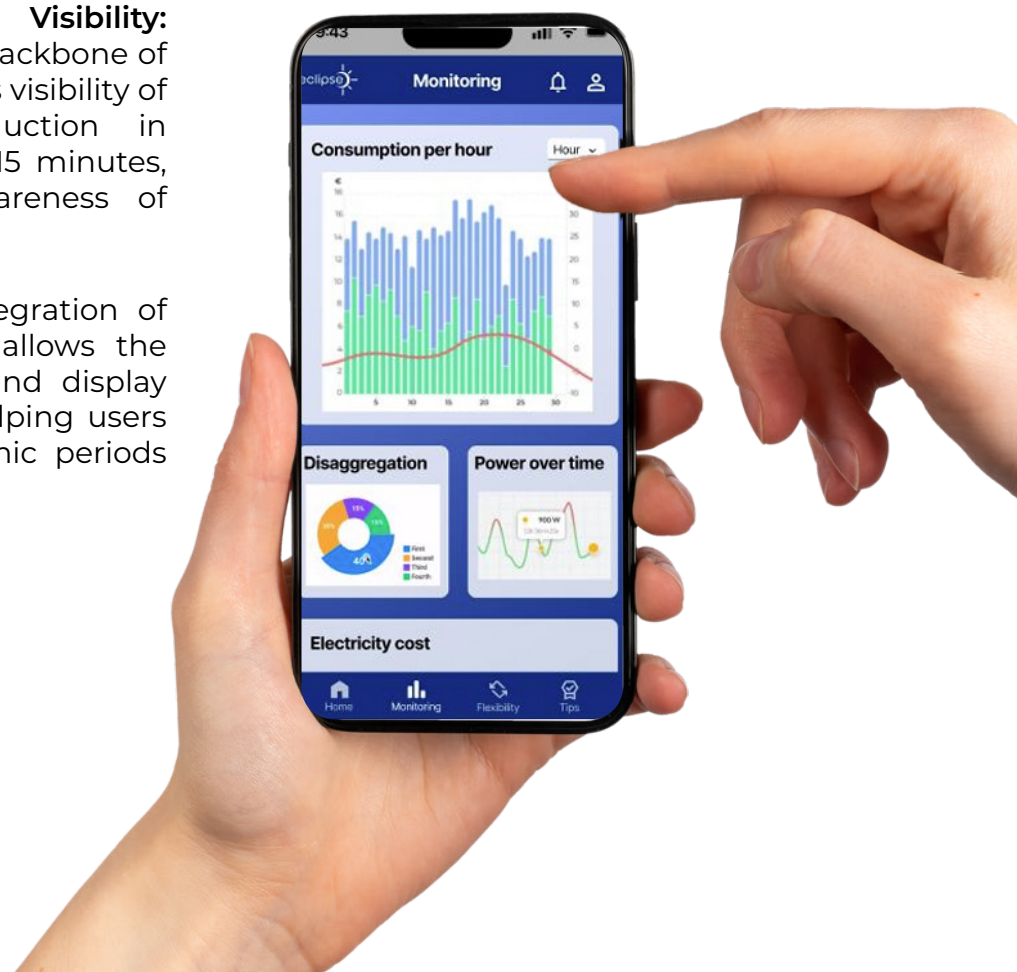
[1] <https://interconnectproject.eu/> [2] <https://onenet-project.eu/> [3] <https://eddie.energy/> [4] <https://www.eclipse.org/>

The ECLIPSE User Application: Your Digital Gateway to Energy Empowerment

The ECLIPSE User Application is more than just a monitoring dashboard; it is a sophisticated tool designed to simplify the complexities of the energy market for the European citizen. Developed as a primary outcome of WP4, the application serves a dual purpose: first, it acts as a ready-to-use solution for pilots lacking an existing interface; second, it provides a technical reference for developers to integrate their own apps with the CERF architecture via standardized APIs.

By transforming passive energy users into active participants, the application allows households to interact with the grid in real-time. It provides a transparent view of energy flows, enabling users to make informed decisions that directly impact their monthly bills and their environmental legacy.

- 1. Intuitive Onboarding:** A seamless registration process that includes secure supply point identification and the classification of household energy assets.
- 2. Dynamic Asset Management:** Users can register and manage specific home appliances, from washing machines to heat pumps, allowing for more precise energy optimization.
- 3. Near Real-Time (NRT) Visibility:** Leveraging the technical backbone of the CERF, the app provides visibility of consumption and production in intervals as short as 1 to 15 minutes, ensuring immediate awareness of energy usage.
- 4. Smart Cost Analysis:** Integration of Time-of-Use (ToU) tariffs allows the application to calculate and display real-time energy costs, helping users identify the most economic periods for high-load activities.



Turning Data into Action: NILM, Alerts, and Gamification

What sets the ECLIPSE application apart is its ability to provide actionable intelligence rather than just raw data. By utilizing advanced algorithms and Machine Learning, the application analyses usage patterns to offer personalized guidance. This proactive approach ensures that users are not just looking at their past consumption ("the rearview mirror") but are actively navigated toward a more efficient future.



- 1. NILM Technology:** Our Non-Intrusive Load Monitoring component is a game-changer. It analyses total power consumption at the main meter and "breaks it down" into individual appliance usage without the need for expensive sub-meters.
- 2. Smart Flexibility Alerts:** Users can set personalized notification thresholds. If consumption exceeds a limit or if the grid faces stress, the app delivers real-time alerts, suggesting voluntary load shifts to improve grid resilience.
- 3. Gamified Sustainability:** To drive long-term engagement, the app includes challenges and "Achievement Badges". Users are rewarded for reaching energy goals, reducing their CO₂ footprint, and adopting greener habits.
- 4. Direct Feedback Loops:** The application facilitates a two-way conversation. Users can receive personalized energy efficiency tips (e.g., lighting, HVAC, insulation) and provide feedback on their implementation, helping the system learn and improve its recommendations over time.

Did you know?

The NILM (Non-Intrusive Load Monitoring) technology, developed by ETRA in the OPENTUNITY Project, can break down your energy usage by individual appliance without the need for expensive sub-meters or extra hardware.



Validation in Action: The 13 European Demo Sites

The true strength of the Common European Reference Framework (CERF) lies in its real-world validation. ECLIPSE DIGITAL is currently deploying and testing its technical solutions across 13 diverse demo sites in 17 EU countries. These pilots act as "living laboratories" where we evaluate how standardized APIs, digital twins, and AI-driven apps perform under different regulatory and climatic conditions.

From managing massive battery aggregations in Sweden to empowering university students in Romania, our pilots cover the entire energy value chain.

Demo # / Country	Pilot Leader	Primary Objective & Focus	Key Digital Tools
#1 France	Voltalis	Residential Flexibility: Engaging households in demand-response markets to balance the grid.	myVoltalis & D4G Insights App
#2 Austria	FHOOE	Energy Communities: Unlocking load-shifting potential through localized data marketplaces.	End Customer & Marketplace App
#3 Spain	i-DE	Electric Mobility: Optimizing EV charging for residential users and corporate fleets.	Retailer App (Flexibility Module)
#4 Bulgaria	ESO	Consumer Empowerment: Providing real-time price signals and efficiency tips to households.	ECLIPSE Open Application
#5 Slovenia	EL	Smart Metering: Implementing 1-minute measurements for advanced billing and savings.	Moj Elektro Portal & EL App
#6 Cyprus	TSOC	Cost-Efficiency: Analyzing consumption patterns to deliver personalized economic tips.	ECLIPSE Open Application
#7 Greece	METLEN	IoT Integration: Managing home energy loads (PV, HVAC) for operational resilience.	ECLIPSE User Application

Demo # / Country	Pilot Leader	Primary Objective & Focus	Key Digital Tools
#8 Sweden	Checkwatt	VPP Aggregation: Managing 15,000 batteries for grid frequency services and arbitrage.	Checkwatt Energy App
#9 Portugal	E-REDES	Low-Voltage Markets: Testing automated flexibility signals for households in urban areas.	Balcão Digital App
#10 Croatia	HOPS	Grid Stability: Using demand response to prevent blackouts and manage grid overloads.	New HOPS Mobile App
#11 Czech Rep.	CEZ Distribuce	Gamified Sustainability: Personalized tariff advice and CO2 reduction challenges.	"Proud" (Current) App
#12 Poland	TAURON	Voltage Stability: Encouraging flexible PV consumption through non-economic incentives.	"eLicznik" (eMeter) App
#13 Romania	NUSTPB	Campus Living Lab: Promoting energy-conscious behavior within university campuses.	FEE Customer App

Scaling the Energy Transition Across Borders

Each pilot utilizes the horizontal building blocks developed in WP4, such as the standardized APIs and the NILM technology for load disaggregation.

This coordinated effort ensures that energy services are interoperable and replicable, laying the foundation for the Common European Energy Data Space.

By combining local expertise with a unified technical backbone, we are transforming European citizens into proactive "*Flexibility Heroes*".





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