



Funded by
the European Union

Horizon Europe

EUROPEAN COMMISSION

European Climate, Infrastructure and Environment Executive Agency (CINEA)

Grant agreement no. 101160684



Use of open-source P2P energy sharing platforms for energy Democratization

Deliverable D 6.2 Strategy for standardization and harmonization

Document Details

Due date	01-09-2025
Actual delivery date	17-09-2025
Lead Contractor	EIFER
Version	1.0
Prepared by	Markus Peter (EIFER), Samrat Bose (EIFER), David Raposo (WattIs), Thomas Heylen (Klimaan), Diogo Pinto Ferreira (INESC ID), Goncalo Gloria (RDN), Alekandr Egorov (RDN), Humberto Queiroz (EDP)
Reviewed by	Hugo Morais (INESC ID), Nicolas Fatras (ARTELYS)
Dissemination Level	PU

Project Contractual Details

Project Title	Use of open-source P2P energy sharing platforms for energy democratization
Project Acronym	U2Demo
Grant Agreement No.	101160684
Project Start Date	01-09-2024
Project End Date	29-02-2028
Duration	42 months

Document History

Version	Date	Contributor(s)	Description
0.1	29.07.2025	M. Peter	First draft
0.2	28.08.2025	M. Peter	Version for reviewers



1.0	10.09.2025	M. Peter	Final document
-----	------------	----------	----------------

Disclaimer

This document has been produced in the context of the U2Demo¹ project. Views and opinions expressed in this document are however those of the authors only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the grating authority can be held responsible for them.

Acknowledgment

This document is a deliverable of U2Demo project. U2Demo has received funding from the European Union's Horizon Europe programme under grant agreement no. 101160684.



**Funded by
the European Union**

¹ <https://u2demo.eu/>

Executive Summary

The tasks and results of U2Demo are closely linked to the challenges of standardization and harmonization. Knowledge of, cooperation with, and exchange of information with these institutions are therefore essential for positioning the project's results. The project aims to achieve the most comprehensive possible presence and participation in institutions and exchange platforms for standardization and harmonization, particularly in Europe and on the global level, through its individual research and industrial partners.

D6.2 identifies and defines a strategy for cooperation with the main standardization and harmonization bodies that will represent a high relevance to harmonization and standardization in order to demonstrate the particular relevance of the research project for standardization and harmonization, as the project progresses. The report also summarizes recent activities of the partners in existing bodies and international platforms and its relevance for U2Demo project.

Table of Contents

Executive Summary	2
Table of Contents	3
Keywords, Acronym	4
1 Introduction	5
1.1 Scope and Objectives	5
1.2 Structure	5
2 Relevant activities and active participation to standardization and harmonization	6
2.1 Simpl Middleware	6
2.2 Contribution to standardization and harmonization working groups in the framework of U2demo project	6
2.2.1 ETIP-SNET	7
2.2.2 ENTSO-E (European Network of Transmission System Operators)	8
2.2.3 BRIDGE Initiative	9
2.2.4 International Electrotechnical Commission (IEC).....	16
2.2.5 Further relevant groups and activities of U2demo partners	21
3 Conclusions.....	23
3.1 Next deliverables.....	23
4 References.....	24

Keywords, Acronym

AI	Artificial Intelligence
BMC	Business Model Canvas
CBA	Cost benefit analysis
CCE	Consumer and Citizen Engagement
CEEDS	Circular Economy Enabled Digital Services
CL-EMP	City-Level Energy Management Platform
DSF	Demand Side Flexibility
DSO	Distribution System Operator
EMD	Electricity Market Design
EPC	Energy performance certificates
EV	Electric vehicle
ENTSO-e	European Network of Transmission System Operators
ETIP	European Technology & Innovation Platform
EV	Electric Vehicle
FAIR	Findability, Accessibility, Interoperability, and Reusability
FCR	Frequency Containment Reserves
GDPR	General Data Protection Regulation
GIS	Geographic information system
KER	Key Enabling Resources
IEC	International Electrotechnical Commission
LCA	Life Cycle Analysis
MCDA	Multicriteria decision analysis
NRA	National Regulatory Authority
P2P	Peer-to-Peer
RES	Renewable energy systems
RDI	Research, Development, and Innovation
RDIC	Research, Development and Innovation Committee
ROI	Return of investments
PV	Photovoltaic
SNET	Smart Networks for Energy Transition
SoE	Strategies of Engagement
SROI	Social return on investment
RES	Renewable Energy Sources
SBMC	Startup Business Model Canvas
TSO	Transmission System Operator
VPC	Value Proposition Canvas
WP	Work Package

1 Introduction

The tasks and results of U2Demo are closely linked to the challenges of standardization and harmonization. Knowledge of, cooperation with, and exchange of information with these institutions are therefore essential for positioning the project's results. The project therefore aims to achieve the most comprehensive possible presence and participation in institutions and exchange platforms for standardization and harmonization, particularly in Europe and on the global level, through its individual partners.

The goal of this task is to propose a strategy promoting the **active participation in the standardization and harmonization bodies**. This participation intends to show the requirements of P2P trading and energy sharing that should be addressed by the standardization bodies to have interoperable and replicable systems. This interaction will extend the project's impact and contribute to the development of the standards to be compliant with the identified needs. On the other hand, the project can benefit from the participation of these working groups by identifying common needs at a global level.

1.1 Scope and Objectives

D6.2 – Strategy for standardization and harmonization identifies and defines a comprehensive strategy for cooperation with the main standardization and harmonization bodies. The report demonstrates the relevance of the research project to standardization and harmonization as the project progresses. Conversely, results and standards from relevant working groups are systematically incorporated into the project throughout its duration. This document outlines the strategy to address key project issues in the fields of standardization and harmonization, while also integrating existing knowledge and standards into the activities of U2Demo. In particular, it presents the current involvement of partners in various standardization institutions, working groups, and international exchange platforms.

The partners are, in many cases, members of standardization organizations and are intensifying these memberships and their cooperation within the framework of project U2Demo. As part of the integration and consolidation strategy, this report describes existing activities of relevant exchange platforms and assigns their relevance to the project. Specifically, it describes relevant content from U2Demo for standardization and harmonization and, conversely, provides an outlook on the relevant results.

Furthermore, as part of the integration and consolidation strategy, ongoing applications to existing international standardization groups, particularly the IEC [1], are being described to further consolidate the work.

1.2 Structure

The task describes relevant topics with reference to and challenge to standardization and furthermore current memberships and activities, admission processes currently in progress, and possible future activities in the context of standardization and harmonization that are highly relevant to the activities within the U2Demo research project.

2 Relevant activities and active participation to standardization and harmonization

2.1 Simpl Middleware

With regards to harmonisation and interoperability “Simpl Middleware” [2] is one of the key technical components currently under consideration to support efforts across all U2Demo pilots. It provides a unified integration layer designed to facilitate secure data exchange, service interoperability, and policy enforcement across diverse technical implementations and organizational contexts.

At its core, the Simpl Middleware acts as a bridge between services and data spaces, offering standardized interfaces and protocols for data exchange. Its role is not only technical, but also regulatory: it ensures that data sharing practices across pilots align with European legislation, such as the Data Governance Act [3] and the Gaia-X [4] principles, by embedding compliance mechanisms, access control policies, and auditability directly into the data flow.

In addition, Simpl promotes protocol harmonization, enabling different actors - regardless of infrastructure, language or data models - to integrate through a common set of APIs, authentication schemes (such as mTLS and OAuth2), and data formats. This consistency helps reduce fragmentation and facilitates the development of interoperable services within the European data economy.

As such, Simpl Middleware represents a strategic asset for Task 6.2, as it can serve as a technical foundation for aligning pilots under a shared integration architecture, enabling not just technical compatibility, but also semantic, legal, and operational cohesion across the broader U2Demo ecosystem. The present approaches will be further introduced and discussed in the standardization exchanges and bodies (s. below).

2.2 Contribution to standardization and harmonization working groups in the framework of U2demo project

As follows, the standardization and harmonization activities in which the research partners of U2Demo are already involved and committed are described and are identified as having and will have a high relevance for the U2Demo project. Others are relevant to the project's progress or offer a sufficiently varied background and opportunities for exchange within the project. In more detail, relevant outputs for the research activities from the committees and possible strategic contributions of the project and the partners are described.

In the following, we outline the current and planned activities for standardization and harmonization among the participating partners, as well as their integration into the relevant strategy of U2demo.

Specifically, the contributions and content from U2Demo to the groups and institutions are described, and, conversely, the added value of the working groups for the project is outlined, in each case according to the individual international working groups.

2.2.1 ETIP-SNET

European Technology & Innovation Platform — Smart Networks for Energy Transition (ETIP-SNET) is an EU-supported stakeholder platform that brings together experts from industry, research, transmission and distribution system operators, regulators and public authorities to coordinate technology, research, innovation and deployment priorities for the energy system transformation.

ETIP-SNET Working Group 1 – Reliable, economic and efficient smart grid system

Working Group 1 addresses the mid and long-term business and technology trends contributing to the overall energy system optimization at affordable investment and operation costs, with particular reference to system development scenarios, network planning, operation, observability and control, asset management, flexibility as seen from the system aspects and resilience. It focuses on system aspects, addressing the main functionalities, quality and efficiency of the electricity system as such and considering the benefits of its integration with the other energy vectors. The flexibility options that are investigated in WG1 are new transmission and distribution technologies (power electronics for instance), the interfaces to be set-up with storage, demand response, flexible generation and the use of synergies with other energy networks, i.e. how to couple the electricity networks with the gas and heat networks.

U2Demo provides a tangible application of WG1's priorities by showcasing how local energy communities and multi-vector energy systems can contribute to grid optimization and flexibility. Relevant connections include:

- System optimization through sector coupling: U2Demo explores how electricity, heating, and mobility systems can be integrated at the community level, directly supporting WG1's aim of assessing the system-wide benefits of multi-vector integration.
- Demand response and user participation: U2Demo deploys real-time demand-side flexibility mechanisms, leveraging prosumer actions and smart controls to support system balancing and reliability reflecting WG1's focus on demand response.

Overall U2Demo acts as a real-world testbed for WG1 concepts, offering validated insights into how integrated community energy systems can enhance system performance, reliability, and economic efficiency all while maintaining a low-carbon and citizen-centric approach.

Working Group 4 – Digitalization of the electricity system and Customer participation

WG4 addresses the use and impact of Information and Communication Technologies as a pervasive tool along the entire value chain of power generation, transportation, and use. The communication layer is one of the pillars of the smart energy system, enabling system observability, monitoring, control and protection, specifically enabling a radical change in the relation between the final user and the energy system. New digital tools (i.e. from smart meters to social networks) linked to the Internet of Things will aim to favour Customer participation in all stages of the development and expansion of the energy system thanks to the analysis of big data generated. The widespread use of digital technologies, however, needs to be accompanied by suitable measures for data and information protection from malicious intrusions and attacks (cybersecurity) and from uncontrolled use of customers data (data privacy).

In particular, WG4 follows on:

- The full digitalization of both the transmission and the distribution networks with new ICT infrastructures, Cybersecurity issues linked to Use of big data, IoT and High Performances Computing;
- ICT infrastructures and technologies that will allow the involvement of the end customers and the retail market players;
- The retail electricity markets empowering customers (favourable environment to choose electricity suppliers and to better control consumptions through new services provided by new market players);
- The Improvement of public awareness of long-term energy challenges and the need to build and protect transmission infrastructure to increase the social benefit of energy use.

U2Demo provides a practical implementation of WG4's priorities by deploying digital tools and engaging citizens in local energy communities to actively participate in the energy system. Relevant connections include:

- Digital empowerment and customer participation: U2Demo implements user-centric platforms that allow citizens to interact with and influence their energy usage, fully aligned with WG4's focus on active prosumer engagement and digital inclusion.
- Cybersecurity and data governance: U2Demo benefits from WG4 recommendations on secure, privacy-preserving data exchange, digital resilience, and interoperability between actors and platforms.

Overall, U2Demo acts as a real-world demonstration of WG4's digitalisation and engagement strategies, showing how trustworthy, AI-driven tools and consumer-centric approaches can unlock flexibility, improve system efficiency, and support a fair, inclusive energy transition.

2.2.2 ENTSO-E (European Network of Transmission System Operators)

WG3 – Flexibility & Markets and WG4 – Power Systems of the Future

ENTSO-E is an association comprising 40 transmission system operators (TSOs) from 36 European countries. It plays a central role in ensuring the secure, efficient, and coordinated operation of Europe's electricity grid (the largest interconnected power system globally) and supports the integration of renewable energy sources (RES) and completion of the internal energy market. ENTSO-E acts as the common voice of TSOs, working to power the European energy transition in line with EU policy and climate goals.

The research, development and innovation committee (RDIC) at ENTSO-E is tasked with coordinating research, development, and innovation (RDI) activities across member TSOs under the EU Clean Energy Package. It oversees strategic documents, such as the RDI Roadmap, Implementation Plan, and Monitoring Report, supports standardization, knowledge sharing, and fosters cooperative innovation among TSOs.

In Q1 2025, ENTSO-E's RDIC Working Groups WG3 – Flexibility & Markets and WG4 – Power Systems of the Future merged into a single entity, now operating as WG4 – Future of Energy Systems. While the structure has evolved, the scope and activities remain unchanged, with work continuing through dedicated Task Forces. R&D NESTER actively follows several WGs,

ensuring alignment with the latest developments and contributing to knowledge exchange. WG4 focuses on enabling a reliable, renewable, and integrated energy future by addressing flexibility, cross-sector integration, and innovative market solutions. In 2025, its key priorities include advancing studies on hydrogen, the water-energy nexus, and the role of data centres in grid flexibility and planning. It is also refining approaches for business models supporting flexibility and assessing long-duration storage solutions to meet the growing flexibility needs driven by high RES integration, electrification of demand, and the transition toward a sustainable, net-zero power system.

U2Demo benefits from WG Regulation's work by:

- Leveraging WG expertise on flexibility markets, long-duration storage, and cross-sector integration to fine-tune U2Demo's strategies and methodologies.
- Gaining access to a network of TSOs, distribution system operators (DSOs), and key stakeholders to validate and deploy solutions in operational environments.
- Aligning with European frameworks and best practices, ensuring scalability, interoperability, and compliance for broader adoption across markets.

U2Demo can contribute to WG Regulation by:

- Bringing real-world insights from diverse Energy Communities on peer-to-peer (P2P) trading, energy sharing, and consumer-driven flexibility models.
- Providing open-source, interoperable tools and validated business models to support the integration of distributed energy resources and cross-sector coupling.

2.2.3 BRIDGE Initiative

U2demo partners are contributing to the European BRIDGE initiative. BRIDGE is a European Energy Transition Initiative is a cooperation initiative launched by the European Commission to create a structured environment for knowledge sharing among EU-funded projects in the fields of smart grids, energy storage, islands, and digitalization. The BRIDGE initiative is structured with four permanent Working Groups (Data Management, Business Model, Regulation, and Customer Engagement), charged with preparing reports and formulating recommendations for the European Commission on various themes linked to the future of the energy sector. Two topics are being studied in the present period: Cybersecurity and TSO-DSO cooperation. Besides that, three Task Forces have been launched after the 2019 BRIDGE General Assembly, to work on specific topics: Energy Communities, Replicability/Scalability Analysis and Joint Communication.

Within BRIDGE, the U2Demo project is represented by partner institutions across the working groups as follows: Regulation (E.DSO, VITO, INESC ID, EUI/FSR, R&D Nester), Business Models (R&D Nester, INESC ID), and Consumer & Citizen Engagement (Klimaan). None of the partners is currently listed for Data Management.

Regulation WG analyses regulatory barriers, enablers, and best practices across EU Member States to accelerate the adoption of innovative energy services, flexibility markets, and energy community models. It promotes harmonisation of rules for peer-to-peer trading, dynamic pricing, grid access for distributed resources, and fair participation in energy and flexibility

markets, while safeguarding consumer rights and ensuring compliance with EU directives such as the Electricity Directive, the Clean Energy Package, and the Data Act.

The Regulation WG convenes Horizon projects to identify regulatory barriers/enablers, and translate project evidence into recommendations for EU/national regulators. In 2023 (last available report) it focused on five challenge areas: (1) consumer market access to value flexibility; (2) collective flexibility via energy communities and energy sharing/P2P; (3) sector coupling/system integration; (4) coordination and integration of energy/flexibility markets; and (5) energy data spaces. The work also aims to inform the Network Code on Demand Side Flexibility and the reform of the EU Electricity Market Design.

Actions, descriptions & main findings

Action 1 — Improve consumers' market access to value their flexibility

What it covered. Follow-up to 2022; examines barriers that prevent individual consumers from using implicit/explicit flexibility (products/services, aggregation, tariff design, prequalification, smart appliances)

Method & status. A scoping questionnaire was prepared with Florence School of Regulation; 27 projects expressed interest. Survey and workshop timing shifted so analysis feeds 2024–25; focus is on collecting project best practices (not only expert opinions).

Main takeaways for 2023. Priorities set; instrumented survey process; detailed results to be delivered with the 2024–25 cycle.

Action 2 —P2P and Energy Sharing

What it covered. Barriers, lessons and recommendations for energy sharing and P2P within overall market design, including the 2024 EMD amendments that operationalise “energy sharing” and expand rights for active customers (Art. 15a) [3].

Method. 3-step process: survey → interactive sessions (MIRO) → ranking & recommendations; 13 projects engaged (ACCEPT, COMMUNITAS, DATA CELLAR, eNeuron, FEDECOM, Flexchess, iFLEX, LocalRES, OMEGA-X, OPENTUNITY, POCITYF, RENErgetic, Eddie)

Main findings.

- Barrier landscape. Projects rated regulatory, financial, technical and social barriers; regulatory complexity and misaligned national transpositions were recurring themes
- Top-5 barriers center on (i) definition/clarity gaps for energy sharing vs. P2P at EU level, (ii) absence of national P2P frameworks, (iii) heterogeneity across Member States, (iv) unclear roles/responsibilities (esp. DSOs), and (v) market/operational bottlenecks that delay participation.
- Lessons & national specificities. Concrete rules by country (e.g., Austria's REC fee reductions; Belgium's region-specific regimes; NL: sharing not yet implemented; PT: legal uncertainty for P2P; ES: distinction between collective self-consumption and energy communities; CH: building-level scope and tariff reductions)
- Recommendations (prioritised). Ranked recommendations, top items include clarifying responsibilities (incl. DSOs/data sharing), issuing EU/MS implementation guidelines for energy sharing (incl. via P2P), creating national/EU WGs with regulators/DSOs/suppliers/participant bodies, simplifying community registration,

enabling local energy markets for P2P, rolling out smart metering & harmonised comms, supporting DSOs' enabling role, cross-sectoral approach (avoid electricity/heat/mobility silos), EU data-governance framework, and benchmarking impact studies.

Action 3 — Facilitate energy & flexibility market coordination and integration

What it covered. From OneNet [5] groundwork: barriers/solutions to move toward coordinated & integrated markets; 26 projects engaged.

Main findings

- Innovation priorities: 1) TSO-DSO coordination schemes, 2) Market participation & consumer engagement, 3) Roles & responsibilities
- Consumer engagement barriers: top issue is low awareness (plus complexity/insufficient value signals)
- Long-term flexibility products as trade-off for grid investments are recognised as the topic with highest priority before the new network code on DSF were available
- Independent market operator: majority favour a third party (not a buyer of flexibility) to bolster neutrality/trust
- Prequalification: prefer national harmonisation with EU-level coordination; FCR may warrant EU-level harmonisation; main obstacles are technical misalignments across systems
- Costs: setting up/participating in flex markets not prohibitive vs. alternatives
- Scaling enablers: tech know-how/replicability, learning from demos, and DSF network code; “free bids” seen least impactful among listed enablers
- Procurement coordination barrier: uncoordinated market timing leads the list.
- Baselineing: alignment across similar products/services desired; some prefer common criteria, others full harmonisation.

Action 4 — Support synergies from sector coupling / sector integration / system integration

What it covered. Aims to support the synergies and opportunities arising from sector coupling by assessing the experience of Horizon 2020 and Horizon Europe projects. Survey-based evidence across e-mobility, heat, household-level integration, and other cross-sector issues; 30 projects participated

Main findings (barriers reported by projects).

- E-mobility services: Data interoperability & data access/privacy (80%); market mechanisms (50%); stakeholder coordination (50%); network regulation (40%); permitting (30%).
- Heat integration: Data interoperability (83%); coordination (67%); market mechanisms (50%); data access/privacy (50%); network regulation (17%)

- Household-level integration: Data interoperability (71%); data access/privacy (57%); market mechanisms (43%); network regulation (29%); coordination & permitting (each 14%)

Overall conclusion: Priorities are standardisation, regulatory evolution, and stakeholder coordination (with 50% of projects seeing barriers in at least one cross-sector; 29% in two)

Action 5 — Support system operators to prepare the grid for 2030

What it covered. Joint workshop (with ISGAN WG6) on applicability of different flexibility mechanisms for DSOs and their trade-off with investments; survey sent to BRIDGE projects

Main findings (5 takeaways):

- DSOs should tailor flex mechanisms (market-based, dynamic connections, tariffs, rule-based) to need and voltage level.
- Combine mechanisms; $>2/3$ of respondents expect growth in market-based options.
- Market-based flexibility effective for short- and long-term; long-term can defer investments.
- No standard methodology (yet) for investment vs. flexibility trade-offs—widely discussed.
- Anticipatory investments are crucial (e.g., RES potential, electric vehicles (EVs) growth)

Next steps: discussion paper and joint activities with ETIP SNET; link to EU Grid Action Plan [6] exploration.

Action 6 — Support Energy Data Spaces (barriers & roles)

What it covered. Cross-WG scoping to align Regulation, Data Management (DERA 3.0), and Business Models around energy data spaces (roles, responsibilities, regulated vs. commercial actors, real-time vs. validated data)

Main conclusions/priorities.

- Focus on roles/responsibilities and regulatory aspects for data spaces; map these to market models and value chains.
- Align with existing clusters (avoid new siloed initiatives); identify best practices and gaps via joint workshops in 2024

In 2025, the current actions of the Regulation WG will have already changed. The new actions are: Action 1 - P2P and energy sharing, Action 2 - Model-based assessment of energy and flexibility market coordination and integration, Action 3 - Supporting the potential synergies arising from increased system integration, and Action 4 - Supporting system operators in preparing the grid for 2030.

U2Demo benefits from WG Regulation's work by:

- Action 1 – Consumer market access to value flexibility. The Action’s 2023 focus and upcoming methodology (flexibility products/services, aggregation rules, tariff design, market processes, smart appliances) give U2Demo ready-made checklists to stress-test its consumer participation, prequalification, and tariff choices across pilots.
- Action 2 – Peer-to-peer & energy sharing. U2Demo can directly reuse the WG’s prioritised barriers and the ranked recommendations (harmonise definitions and roles; reduce administrative burden; foster supplier-inclusive models; provide technical/IT guidance; update taxation/tariffs; enable sandboxes and local markets; ensure transparency & consumer protection; clarify responsibilities). These points de-risk U2Demo’s energy-sharing governance and platform design. Also, Action-aligned design choices based on WG’s A2 recommendations on rights/responsibilities, metering/sub-metering and settlement that directly inform U2Demo’s energy-sharing and P2P toolchain, where settlement/billing and governance must fit national rules and EC by-laws.
- Action 3 – Market coordination & integration. Insights from the OneNet/BRIDGE workshop on barriers (data sharing/standardisation gaps, lack of harmonised processes and network codes, NRA approval hurdles, low consumer awareness, and DSO/TSO coordination issues) help U2Demo align its flexibility procurement and market-coupling choices with the most material integration blockers observed EU-wide.
- Action 6 WG focus on roles/liability dovetails with U2Demo’s intent to leverage existing data spaces/middleware; the project’s security and identity framework (OAuth2/mTLS, RBAC/ABAC, GDPR) aligns to the WG’s trust requirements.
- Navigating complex national contexts: U2Demo pilots operate in Italy, Belgium, Portugal, and the Netherlands, each with distinct legal frameworks for energy sharing, flexibility, and market participation. WG outputs provide clarity on compliance pathways and highlight emerging opportunities under evolving EU legislation.
- Aligning data governance with EU principles: WG guidance on GDPR, data sovereignty, and cross-border data exchange supports U2Demo’s secure, citizen-centric handling of energy and personal data across all project activities.
- Anticipating regulatory evolution: Insights into forthcoming EU network codes and national transpositions help U2Demo design its technical and market solutions for future readiness, ensuring replicability beyond the demonstration phase.

U2Demo can contribute to WG Regulation by:

- Providing multi-country evidence: The project will generate concrete operational feedback from pilots with different governance models, asset mixes, and market interactions, highlighting how regulation enables or limits innovation in real conditions.
- Informing regulatory recommendations: Findings on licensing requirements, settlement rules, data access constraints, and sector coupling integration will feed directly into WG discussions and policy briefs to the European Commission and National Regulatory Authorities.
- Algorithms that co-optimize sharing and flexibility. The project will share open-source results on P2P matching + DSF participation, baselines which might be useful for WG 1/3 on product/market design and coordination.

- Regarding Action 6 (data spaces): Offer the U2Demo semantic stack (hybrid ontology reusing SAREF/SEAS/ENERSHARE/others + U2Demo modules extensions) and security/GDPR controls (ISO/IEC 27001, IEC 62443, IEC 62351, NIS2/NCCS alignment) as concrete building blocks for role mapping, data minimisation and auditable data-sharing patterns within energy data spaces. Interoperability & data-space patterns. U2Demo’s semantic models and Simpl middleware integration (security, identity, logging, API profiles) can serve as concrete “how-to” patterns for WG #6 work on roles, responsibilities and liability in energy data spaces.

Overall, U2Demo acts as a living laboratory for regulatory experimentation, offering the WG a rich set of scenarios regarding energy sharing and P2P that can inform the next generation of enabling policies for energy communities and flexibility markets and provide valuable inputs to future projects in the area.

The **Business Models WG** defines common language, tools, and processes for describing and valuing business models across BRIDGE projects. In 2023–24 it organised its work into three tasks: Task 1 (tools to capture business ideas & build BMs), Task 2 (quantification methods for costs/benefits), and Task 3 (data valorisation & links to Common European Energy Data Spaces, incl. a new “market uptake” sub-task). Core takeaways include: most projects use BMC/VPC but need a standardised, stage-appropriate process (“Business Models Cookbook”); quantification needs shared methods and templates (CBA, LCA, ROI, MCDA, SROI, scenarios, EPC) plus lessons from OneNet/EV4EU/iFLEX/RE-EMPOWERED; and data is often not treated as a KER, so practical guidance on data-space building blocks and governance is being produced.

U2Demo benefits from WG Business Models’ work by:

- Leveraging proven archetypes: WG outputs on business model templates — such as flexibility-as-a-service, P2P trading marketplaces, or hybrid prosumer–aggregator roles can help U2Demo shape offerings that can attract participation and investment.
- Step-by-step BM design. The WG’s guide and planned “Business Models Cookbook” help U2Demo pick the right toolchains (BMC, VPC, SBMC) per stage and share good practices through workshops, reducing re-work and aligning partner expectations on value propositions, channels, and revenue streams.
- Mapping value for all stakeholders: Methodologies from the WG guide U2Demo in quantifying economic, social, and environmental benefits for prosumers, DSOs, retailers, and local authorities, ensuring equitable participation and long-term engagement.
- Data as a business asset. The WG documents how to valorise data (treat datasets as KERs, address ownership/GDPR/FAIR, and link BM design to CEEDS). Give to U2Demo a ready checklist for consent, metadata, interoperability and governance decisions that underpin scalable services.
- Ensuring scalability: WG insights on market design, customer acquisition, and partnership structures strengthen U2Demo’s ability to replicate successful approaches beyond the pilot regions.
- Market uptake focus. The new sub-task on market uptake and the planned repository of successful results help U2Demo position its KERs.

- Cross-initiative alignment. Joint activities with ETIP SNET and the Regulation WG (webinar; live poll priorities) clarify where regulatory sandboxes and role definitions intersect with BM choices, useful framing for U2Demo's exploitation and replication plan

U2Demo contributes to WG Business Models by:

- Testing revenue and incentive schemes in real markets: Across its pilots, U2Demo trials innovative internal pricing, dynamic tariffs, reward mechanisms, and community-led investment models, generating performance and acceptance data for different contexts.
- Validating replicability across geographies and vectors: With demonstrations spanning electricity, heating, and mobility integration, U2Demo offers empirical input to refine WG frameworks for assessing scalability in multi-vector and cross-sector business models.

In this way, U2Demo both applies and enriches WG Business Models' tools and recommendations, creating a feedback loop where lessons from real-world pilots enhance the WG's strategic guidance for future projects and policy initiatives.

The **WG Consumer and Citizen Engagement (CCE)** acts as a central hub for generating and sharing knowledge on how to effectively involve citizens in the energy transition. It recognises individuals not merely as consumers, but as active citizens demanding a greater say in decision-making processes. The WG's activities are structured into three specialised subgroups: Smart Tools, Indicators of Engagement, and Strategies of Engagement (SoE).

The SoE subgroup is dedicated to identifying and assessing methodologies for effective stakeholder engagement. During the 2024-2025 period, its work concentrated on two critical themes:

- **Inclusivity and Energy Poverty:** The subgroup found that while inclusive practices are becoming more common, their implementation is uneven. Effective strategies require long-term commitment and trust-building through co-design with affected communities.
- **Artificial Intelligence (AI) and Engagement:** AI was identified as a powerful tool for enhancing communication and analysing data, but it also presents significant risks related to bias, digital exclusion, and privacy. The key recommendation is to foster a "human-AI partnership".

For the 2025-2026 period, the SoE subgroup plans to expand its focus to include the topics of Social Acceptance and Education and User Engagement.

Benefits of the WG CCE for the U2Demo Project:

- **Access to Best Practices:** U2Demo can directly apply the WG's established findings on effective engagement, avoiding the need to develop new strategies from scratch.
- **Guidance on Inclusivity:** The SoE subgroup's work provides U2Demo with a ready-made framework for identifying vulnerable groups and ensuring equitable participation, aligning with the project's goal of alleviating energy poverty.

- **Insights on AI and Ethics:** The findings of the Smart Tools and SoE subgroups offer direct guidance for the responsible development of the decision support algorithms within U2Demo's open-source platform.
- **Standardised Metrics:** By adopting the common metrics being developed by the Indicators of Engagement subgroup, U2Demo can ensure its results are comparable with other projects, thereby enhancing its scientific impact.

Potential Contributions of U2Demo to the CCE WG:

- **Case Study on Social Acceptance:** U2Demo's research into consumer motivation will provide the SoE subgroup with invaluable empirical data for its new focus on Social Acceptance.
- **Practical Open-Source Platform:** The development of the project's P2P platform serves as a powerful, real-world case study for the Smart Tools subgroup, offering insights into architecture and user co-design.
- **Empirical Data from Pilots:** U2Demo will test its platform across four diverse pilots, gathering extensive data on user engagement and behaviour that will be a rich source of information for all subgroups.
- **Addressing Energy Poverty and Education:** The project's focus on a social housing neighbourhood in its Belgian pilot, combined with its planned clarification workshops, will directly contribute to the SoE's future work on Education and User Engagement.

2.2.4 International Electrotechnical Commission (IEC)

Membership and contribution to IEC Committees and working groups are identified as key activities for U2demo to share results, discuss outcomes, and benefit from the recent discussion in international communities.

The project partners have concluded that they will focus their standardization efforts on IEC activities as the project progresses. Key partners are committed to acquiring membership in the IEC group in accordance with the national admission process via their mirror institutions. In this case, these are the partners from Germany, Portugal, and Belgium. The contributions and activities were coordinated with the IEC SyC Smart Energy committees.

The following section outlines the various activities, contributions and memberships of partners that are relevant and of interest to the International Electrotechnical Commission. As part of the strategy for its further course, contributions from U2Demo to these working groups will be intensified, significant results from the working groups will be evaluated, and the number of active, significant partners will be increased through national applications to these groups. The application process is being handled by the national mirror committees and organizations, which are currently still in the process of confirmation. Regarding Working Group 8 of IEC SycSmartEnergy, activities on the part of IEC will not resume until fall 2025 due to a vacancy in the group's leadership. Nevertheless, the activities in this standardization group were identified as crucial for the U2Demo project.

TC8: System aspects of electrical energy supply

The technical committee aims to develop international standards and other deliverables on the topic of electrical energy supply, particularly regarding RES and electric energy storage. U2Demo can benefit from the TC work carried out in the following actions:

- Action 1: Horizontal standards for voltages, currents and frequencies for electrical systems and equipment (IEC 60038, IEC 60059 and IEC 60196). Compliance with these standards can impact the following WPs in U2Demo:
 - WP2 and WP4: Algorithms developed in these WPs can consider the reference values and limits set by these standards as constraints that need to be satisfied to ensure secure grid operation.
 - WP5: Validation of the field test results of compliance with the standards.
- Action 4: Requirements for interconnection of distributed energy resources (DERs) with the grid according to laws and standards adopted by local regulators, authorities and governments from each country (IEC 62786). Compliance with these standards can impact the following WPs:
 - WP5: The specifications of the pilots should comply with the existing international standards.

U2Demo contributes to the TC work by:

- Applying existing standards for the interconnection of DERs with the grid and documenting the field test results from energy communities' operation with DERs. Renewable generation sources and electric energy storage play a key role in the operation of ECs, requiring the adoption of country-specific standards. The fact that the pilot sites are four energy communities in four different countries (Portugal, Italy, Belgium and Netherlands) can contribute with field experience to enrich existing standards. This contribution will be primarily made in WP5, utilizing the field test results, and in WP6, assessing the project's technological implementation.

SC 8A: Grid Integration of Renewable Energy Generation

The technical sub-committee aims at the development of international standards and other deliverables on the topic of renewable grid integration, particularly those that can reflect the impact that the volatility of a high percentage of renewables, such as PV or wind, can introduce on normal grid operation.

U2Demo can benefit from the SC work carried out in the following actions:

- Action 2: Development of specifications for the evaluation of renewable energy power forecasting results. Compliance with these specifications can impact the following WPs in U2Demo:

- WP2 and WP4: Forecasting algorithms in these WPs can consider the specifications for the evaluation of renewable energy power forecasting.
- Action 6: Development of technical requirements for multi-time scale capacity prediction technology and participation in electricity markets. Compliance with these technical requirements can impact the following WPs in U2Demo:
 - WP2 and WP4: Participation mechanisms on flexibility and energy markets should be developed such that technical requirements are satisfied.
- Action 7: Development of the roadmap for grid integration of renewable energy generation. This action is related with the work to be developed in the following WPs:
 - WP5: Field test results from the pilot sites can contribute to the development of this roadmap.
 - WP6 and WP7: Assessment and alignment of the results obtained in the project with initiatives such as BRIDGE can contribute to the development of this roadmap.

U2Demo can contribute to the SC work by:

- Applying existing standards for energy forecasting and documenting the field test results for AI-based forecasting algorithms to be implemented in the ECs of the U2Demo pilots.
- Applying existing standards for capacity prediction and participation in electricity markets and documenting the field test results that result from the EC internal scheduling mechanisms to participate in these markets.
- Applying existing standards for grid integration of renewable energy generation and documenting the field test results from the integration of PV in the pilot sites.

These contributions will be primarily made in WP2 and WP4 with the development of forecasting algorithms, in WP5 with the field test results and WP6 with assessment of the project technological implementation.

SC 8C: Network Management in Interconnected Electric Power Systems

This technical sub-committee aims at the development of international standards and other deliverables on the topic of network management, providing guidelines for the design, planning, operation, control, and market integration in interconnected electric power systems.

U2Demo can benefit from the SC work carried out in the following actions:

- Action 2: Development of technical specifications for stable grid operation, with particular focus on business use cases of flexibility services. Compliance with these technical specifications can impact the following WPs in U2Demo:

- WP1: The business use cases defined in this WP should follow the technical specifications defined for flexibility services.
- WP2 and WP4: Participation mechanisms on flexibility and energy markets should be developed such that technical requirements are satisfied.
- WP5: Field test results should be aligned with the technical requirements set for participation on flexibility and energy markets.
- Action 7: Development of documents regarding carbon emission management, with particular focus on carbon emission metering, data collection and processing, low carbon planning and operation and trading of power systems. This action is related with the work to be developed in the following WPs:
 - WP2 and WP4: Decision support methods should give insights to the EC members regarding the environmental impact of their decisions on scheduling, participation in energy sharing and P2P transactions and flexibility and energy markets.
 - WP6: The carbon impact assessment for pilot sites when EC members engage in energy sharing and P2P transactions and flexibility and energy markets can contribute to this action.

U2Demo can contribute to the SC work by:

- Applying existing standards for participation in flexibility services and documenting the field test results for participation in flexibility markets to be implemented in the ECs of the U2Demo pilots
- Documenting the carbon emission management efforts carried out in the management of ECs of U2Demo.

These contributions will be primarily made in WP2 and WP4 with the development of mechanisms for scheduling, participation in energy sharing and P2P transactions and flexibility and energy markets, in WP5 with the field test results and WP6 with assessment of the project technological implementation.

IEC System Committee Smart Energy (SyC Smart Energy)

Membership and contribution to SyC Smart Energy are identified as key activities for U2demo to share results, discuss outcomes, and benefit from the recent discussion in international communities. Key partners are committed to acquiring membership in the IEC group through their respective national admission processes, via their designated mirror institutions.

The IEC System Committee Smart Energy (SyC SmartEnergy), established by the International Electrotechnical Commission (IEC), focuses on systems-level standardization, coordination, and guidance in the domains of Smart Grid and Smart Energy, including interactions with heat and gas systems. Its primary goal is to provide a framework for interoperability and efficient deployment of smart energy systems worldwide by coordinating the efforts of various IEC Technical Committees (TCs), Subcommittees (SCs), and external Standards Development Organizations (SDOs).

WG8: Distributed energy trading infrastructure

IEC SyC Smart Energy WG 8 is a working group within the IEC System Committee (SyC) Smart Energy. This working group focuses on aspects related to distributed energy trading and other smart energy system topics. The IEC SyC SmartEnergy is responsible for system-level standardization, coordination, and guidance in smart energy, particularly in smart grid and smart energy domains, encompassing the entire electricity supply chain from generation to the customer level. WG 8 specifically deals with distributed energy trading, and this reflects a focus on market mechanisms and technical standards facilitating the integration of distributed energy resources into energy trading systems.

More broadly, IEC SyC Smart Energy coordinates use cases and reference architectures for smart energy grids, aiming to avoid conflicts across use cases and promote a system perspective. This supports the development of standards crucial for smart grid evolution, including grid codes, connection requirements for distributed generation, and network management. IEC SyC Smart Energy WG 8 focuses on distributed energy trading. It operates as part of the IEC System Committee for Smart Energy for system-level standardization in smart grids and smart energy. It fits within a broader IEC effort to support smart grid evolution through use cases, reference architectures, and coordinated standardization with related TCs. The group helps to address the increasing complexity of smart grids by enabling standards that support market and technical integration of distributed energy resources into the electricity supply chain.

Membership and contribution IEC SycSmartEnergy, WG8

During the first year of the U2demo project, the question of contributions for standardization approaches has concluded that the focus in terms of content and structure should be concentrated on activities and exchanges within the System Committee Smart energy of IEC. To this aim, direct consultations with the acting Chair of the IEC Smart Energy Systems Committee were initiated. The participation of key partners within U2demo was agreed upon, as was the application process to the IEC via the national institutions. The foundation of a specific ad hoc group within SyCSmartEnergy is also a future option.

Active participation by the partners has been identified as a project strategy in the primary relevant activity level for standardization and harmonization, enabling the provision of outputs and exchange with the U2Demo project. As part of the standardization and harmonization strategy, to diversify and enhance U2Demo representation, particularly in WG 8 Distributed energy trading infrastructure, represented by various partners and countries, and to increase the working group's presence through national applications.

The admission process, national mirror committees, and readiness are clearly outlined and transparent, and were requested by partners at national mirror organizations in Portugal, Germany, and Belgium.

As of August 2025, the status of participation is as follows:

EIFER, Germany: Confirmed active member of IEC SyCSmartEnergy, WG 8

INESC, Portugal: National application to IEC SyCSmartEnergy, WG 8, ongoing.

KLIMAAN, Belgium: National application to IEC SyCSmartEnergy, WG 8, ongoing.

IEC SyCSmartEnergy, Working Group 8: Following a change of convenor, the working group was reorganized in the summer of 2025 and will resume its work with contributions from U2demo after the plenary meeting in October 2025.

The activities in IEC SycSmartEnergy, WG 8 will be reorganized and coordinated in the course of 2025. Under certain circumstances, there may also be a fundamental re-orientation of the working group. This finally presents an excellent opportunity to make a significant contribution to the working group by sharing content from the U2Demo project.

2.2.5 Further relevant groups and activities of U2demo partners

Citizen Energy Advisory Hub [7]

A Commission initiative that boosts a bottom-up, citizen-led energy transition by helping communities, municipalities, small businesses, and citizens self-consume renewables and shift demand to better control bills. It supports faster implementation of EU legislation and enabling conditions and provides direct technical assistance to 120 selected citizen energy initiatives, plus resources, networking, and local dialogues. U2Demo can plug in by nominating its pilot communities for this assistance, reusing Hub materials to strengthen citizen engagement, and sharing anonymised lessons from its pilots to enrich the Hub's knowledge base.

European Energy Communities Facility [8]

Launched in September 2024 to run until February 2028, this facility empowers energy communities by offering small lump-sum grants and targeted training. It will support at least 140 communities to develop robust business plans and replicable models, with calls open to communities in all EU countries plus Iceland, Ukraine, Moldova and North Macedonia. The facility builds on the Energy Communities Repository, the Rural Energy Community Advisory Hub, and the European City Facility. U2Demo can collaborate by using the Facility to finance business plan development for its pilots (and spin-offs), align with training to standardize replication, and provide feedback on implementation results to strengthen the Facility's guidance.

ITU-T Y.4498 FRAMEWORK OF CITY-LEVEL ENERGY DATA SHARING AND ANALYTICS AMONG BUILDINGS [9]

An ITU-T Recommendation that specifies requirements and a reference architecture for city-level energy management, enabling interoperable data exchange, sharing, and analytics among buildings to support planning, operations, and services in smart cities. It defines models (conceptual, data, and process), the CL-EMP (City-Level Energy Management Platform) reference architecture, interface/functional requirements, and security & management

functions. It also includes use cases such as integrated building energy management, open-API-based city energy data sharing, and GIS-based city energy planning.

Y.4498's architecture lays out core functions, interconnection, data/knowledge, interface, service support, and security/management, and stresses standardised energy data types and exchange methods so that buildings with different load/generation profiles can share information to raise efficiency at city scale. Cities and platforms can use it as a blueprint to design APIs, governance, and analytics workflows that respect privacy and security while enabling optimization and market participation.

Regarding U2Demo potential alliance with this initiative regarding designing or scaling community/city platforms, Y.4498 gives a ready reference for API design, data models, and governance/security at city scale.

3 Conclusions

During the course of the one-year project, key content and institutions for establishing U2Demo's partners' participation in international standardization and harmonization efforts were developed and coordinated within the task. Many of the partners are already active at various levels of standardization. Relevant output of these activities, as well as U2demos results contribution, have been outlined. This report presents the relevant platforms and institutions, their potential for contributing to the results of U2Demo, and finally, the impact of the results achieved there on the project. U2Demo will actively contribute to harmonization frameworks by:

Supplying empirical evidence and policy recommendations to regulatory groups to clarify definitions, roles, and best practices for peer-to-peer energy sharing, flexibility markets, and energy communities.

Sharing open-source tools, business models, algorithms, and semantic models (including middleware and security mechanisms) with standardization bodies.

Helping to align technical, semantic, and legal interoperability across Europe through active engagement in working groups (BRIDGE, ETIP-SNET, ENTSO-E, IEC) and through the development of replicable and scalable approaches.

Contributing lessons learned, user engagement strategies, and results from multi-country pilots to shape evolving standards and harmonization actions, particularly in data governance, consumer participation, and grid integration.

As a future strategy in the further course of the project, the activities and contributions, particularly regarding the IEC, will be intensified, and opportunities for international standardization institutions to contribute to the content and relevance of U2Demo will be continuously reviewed.

3.1 Next deliverables

No further deliverables are planned within the scope of Task 6.2.

4 References

- [1] IEC System Committee Smart Energy, SyC Smart Energy. <https://syc-se.iec.ch>
DKE German Commission for Electrical, Electronic & Information Technologies. IEC/SyC Smart Energy. <https://www.dke.de/de/ueber-uns/dke-organisation-auftrag/dke-fachbereiche/dke-gremium?id=3008885&type=dke%7Cgremium>. Accessed: August 30, 2025.
- [2] European Commission. Simple programme. <https://simpl-programme.ec.europa.eu/>. Accessed: August 30, 2025.
- [3] European Union. Regulation (EU) 2022/868 of the European Parliament and of the Council of 30 May 2022 on European data governance and amending Regulation (EU) 2018/1724 <https://eur-lex.europa.eu/eli/reg/2022/868/oj/eng>. Accessed: August 30, 2025.
- [4] Gaia-X European Association for Data and Cloud AISBL. <https://gaia-x.eu/>. Accessed: August 30, 2025.
- [5] OneNet. EU-funded project. <https://cordis.europa.eu/article/id/449480-it-architecture-supports-flexibility-in-energy-markets/>. Accessed: August 30, 2025.
- [6] European Commission. EU Grid Action Plan for Grids. 2023. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_6044 Accessed: August 30, 2025/. Accessed: August 30, 2025.
- [7] European Commission. Citizen Energy Advisory Hub. https://citizens-energy.ec.europa.eu/about-citizen-energy-advisory-hub_en, Accessed: August 30, 2025.
European Commission. European Energy Communities Facility, 2024.
- [8] https://managenergy.ec.europa.eu/managenergy-discover/managenergy-news/european-energy-communities-facility-launches-first-call-proposals-2025-05-13_en. Accessed: August 30, 2025.
- [9] International Telecommunication Framework (ITU). Framework of city-level energy data sharing and analytics among buildings. <https://www.itu.int/epublications/ar/publication/itu-t-y-4498-2024-07-framework-of-city-level-energy-data-sharing-and-analytics-among-buildings/en>. Accessed: August 30, 2025.