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OPEN LETTER

REVISED FEDECOM: Enabling cross-border energy exchange by federating energy communities

[version 2; peer review: 2 approved, 1 approved with reservations]

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Abstract

The FEDECOM project (Federated-system approach for flexible and interoperable energy communities) is a European Union-funded project aimed at fostering the integration and flexibility of local energy systems by demonstrating the potential of cross-border energy exchange by energy sector coupling through a federation of energy communities. The project seeks to provide economic benefits, improve grid stability and reliability, and contribute to the decarbonisation of the energy system. FEDECOM combines direct and indirect electrification strategies to leverage synergies and offers a cloud-based platform for managing local energy systems, including power, gas, thermal energy, industry, and mobility sectors. This paper discusses FEDECOM's approach to energy management at multiple pilot sites, seeking to optimize resource use, enhance grid stability, and promote sustainable energy practices. It presents an overview of the FEDECOM project's goals, structure, pilot sites, and technical innovations, including peer-to-peer trading, semantic data modeling, and a novel platform architecture.

Keywords

Cross-border energy exchange, Energy sector coupling, Energy communities, Renewable energy, Cloud-based energy management, FEDECOM platform, Peer-to-peer energy trading

Open Peer Review

Approval Status ✓ ? ✓

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version 2 (revision) 10 Feb 2025	✓ view		✓ view
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2. **Osman Zeki Gökçe**, Istanbul Medipol University, Istanbul, Turkey
3. **Weiguang Cai**, Chongqing University, Chongqing, China

Any reports and responses or comments on the article can be found at the end of the article.

HE This article is included in the Horizon Europe gateway.



This article is included in the Sustainable Places 2024 collection.

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Author roles: Lennard Z: Writing – Original Draft Preparation

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REVISED **Amendments from Version 1**

This updated version incorporates several refinements based on the valuable feedback from the reviewers. Below is a summary of the specific changes made to enhance clarity, empirical support, and technical depth:

1. **Expanded Rationale for Challenges and Solutions:** The introduction and regulatory challenges sections have been revised to provide a more detailed analysis of inefficiencies in regulatory harmonization, market access for prosumers, and technical interoperability. FEDECOM's federated model is now more explicitly contrasted with centralized grid approaches.
2. **Engagement with Alternative Perspectives:** A new comparative analysis has been included, examining alternative frameworks such as the EU's Clean Energy Package and independent blockchain-based P2P trading initiatives. This section clarifies FEDECOM's unique value proposition.
3. **Incorporation of Empirical Data:** Data from pilot studies in Spain and Switzerland have been integrated, demonstrating measurable benefits such as reductions in line losses (18%) and improvements in local energy trading efficiency (12%). Case study results highlight how FEDECOM's load balancing strategies have optimized grid stability.
4. **Enhanced Technical Details:** The discussion on platform scalability and P2P trading mechanisms has been strengthened with details on FEDECOM's hybrid consensus mechanism and adaptive market-clearing model, illustrating how it ensures transaction efficiency and security.
5. **Clarified Differentiation from Existing Solutions:** A dedicated section now explains how FEDECOM's approach surpasses traditional renewable forecasting and isolated P2P trading models, emphasizing its integrative federated structure.
6. **Policy and Regulatory Expansion:** The policy section has been expanded with details on FEDECOM's engagement with the BRIDGE initiative and its alignment with EU cross-border energy trading policies.
7. **Socio-Economic Impact Analysis:** New data have been added to quantify energy cost reductions (15%) and job creation projections (8%) in participating regions, supporting FEDECOM's broader economic benefits.

Any further responses from the reviewers can be found at the end of the article

1. Introduction

Energy systems across Europe are transitioning towards increased sustainability, flexibility, and local autonomy, supported by recent policy directives such as the European Green Deal. FEDECOM, a collaborative EU-funded project, addresses this transition by focusing on federated energy communities and sectoral coupling to improve grid stability, economic viability, and decarbonization. Specifically, the project is developing innovative solutions for a sustainable energy system, addressing regulatory barriers, promoting digitalization through a cloud-based platform and advanced data analytics, and creating new market opportunities for energy communities, service providers, and technology developers, contributing to economic growth and job creation.

Despite the growing adoption of federated energy communities, significant inefficiencies persist, particularly in regulatory harmonization, market access for prosumers, and technical interoperability. FEDECOM addresses these challenges through a modular architecture that enables seamless integration of decentralized energy assets. Unlike traditional centralized grid management approaches, FEDECOM's federated model enhances local decision-making while ensuring compliance with cross-border energy regulations.

2. Objectives and scope

FEDECOM is a consortium of international organizations working to develop a cloud-based platform that uses Information and Communication Technologies (ICT) to promote energy efficiency and sectoral coupling. The platform will use Distributed Energy Resources (DER) and storage systems in pilot sites with varying equipment and climatic conditions. The project aims to enable energy sector coupling, integrate local energy systems, optimize resource management, and develop partner-backed plans for large-scale replication. FEDECOM's scientific and technical objectives include optimizing operations, promoting efficient energy consumption and generation, promoting peer-to-peer (P2P) energy trading, and promoting a more sustainable and resilient energy infrastructure. The project's activities range from creating tools for P2P trading to optimizing access to the energy market and renewable energy (RE) use.

Several alternative approaches exist to promote energy community integration, such as the EU's Clean Energy Package and independent blockchain-based P2P trading initiatives. However, these approaches often fail to address scalability and economic viability across heterogeneous regulatory environments. While some argue that direct government incentives provide a more straightforward pathway, FEDECOM differentiates itself by fostering market-driven innovation through multi-layered stakeholder engagement and adaptive regulatory compliance mechanisms.

3. Methods

3.1 Platform architecture and key functionalities

The FEDECOM platform consists of 14 modular components, each designed to address specific energy community needs. Key functionalities include forecasting (Section 3.1.1), optimal energy management (Section 3.1.2), P2P energy trading (Section 3.1.3), a semantic data model (Section 3.1.4), and a Multi-Criteria Decision Analysis (MCDA) recommender (Section 3.1.5). Forecasting involves prosumer generation, while optimal energy management uses real-time dispatching considering supply and demand sides. Demand response optimizes local energy systems and unlocks 30% of demand side flexibility. The platform also facilitates energy and flexibility trading within and between communities, ensuring transparency and transparency in contractual frameworks.

3.1.1 Forecasting module. The FEDECOM platform's Forecasting Module is A real-time generation forecasting tool for prosumer resources that leverages historical and real-time data to predict production and consumption levels across

communities, facilitating efficient energy dispatch and demand response. It is designed to provide accurate predictions of both RE generation and energy demand. This module will utilize a variety of techniques, including physical models, data-driven forecasting methods, and machine learning algorithms, to generate forecasts over different time horizons, ranging from one hour to seven days ahead. RE generation forecasts will be based on factors such as weather data, while energy demand forecasts will incorporate household, building, and community-level profiles. The Forecasting Module will also estimate the share of flexible load, providing valuable input for the optimization of energy systems. The accuracy of these forecasts will be assessed using metrics such as Root Mean Square Error (RMSE). The development of forecasting algorithms for RE generation and thermal demand is already underway, with initial algorithms being tested and validated using historical datasets. These forecasts are essential for informing the operation of other FEDECOM modules, such as the Model Predictive Control (MPC), enabling efficient energy management and maximizing the utilization of RE sources (RES).

3.1.2 Optimal Energy Management System (EMS). The FEDECOM platform's Optimal Energy Management System is an integrated solution designed to manage energy communities effectively. It leverages a suite of predictive, modeling, and optimization capabilities to facilitate cost-optimized management of energy assets connected to the communities. The system monitors various data points from energy assets, including building thermal behavior and energy loads, storage system status, RE generation, and potential energy flexibility of each asset. This information is then processed by different modules within the platform, such as the Energy Dispatch Model, Grid Analytics & Diagnostics, and MPC Service. These modules work together to analyze the data and propose optimized scenarios for energy asset usage within the community. The system also enables peer-to-peer energy and energy flexibility trading within and between communities using a blockchain-based local marketplace, facilitated by the Open Marketplace module. The system aims to ensure efficient, stable, and reliable grid operation while promoting energy savings and economic benefits for the community.

3.1.3 Peer-to-Peer energy trading. The FEDECOM platform facilitates P2P energy trading within and between energy communities using a blockchain-based local marketplace, aiming to optimize local energy use and grid resilience. This marketplace, built on the Energy Web Chain and Substrate-based blockchain tools, ensures secure data flow, data integrity, and transparent transactions through immutable distributed ledger mechanisms. FEDECOM's P2P trading concept allows community members to buy and sell excess RE generation, prioritizing self-consumption and minimizing reliance on the traditional grid. This localized trading can reduce grid congestion and network charges, particularly when energy exchange occurs within the same distribution network. The platform supports different P2P trading models: third-party to third-party, energy communities to third parties, and energy communities to energy communities. The latter model fosters a network of energy communities exchanging energy based on complementary production and consumption patterns, maximizing local RE utilization and supporting grid stability. While the RED II directive introduced P2P trading of RE, its implementation remains limited in most member states, often restricted to community trading with a single predefined price, as opposed to FEDECOM's vision of a dynamic local market with variable pricing.

FEDECOM's approach to P2P trading extends beyond conventional blockchain frameworks by integrating a hybrid consensus mechanism that balances security with transaction efficiency. Additionally, its adaptive market-clearing mechanism dynamically adjusts pricing based on real-time demand-supply fluctuations, ensuring cost-effective energy exchanges for prosumers.

3.1.4 Semantic data model. The FEDECOM platform utilizes a Semantic Data Model implemented as an ontology to ensure semantic interoperability between the different modules and components of the platform. This ontology establishes a common vocabulary for information exchange within the FEDECOM platform, allowing for a unified understanding of the various data points and relationships between different energy assets and systems. The Semantic Data Model is essential for enabling the platform to process data from diverse sources, including building energy systems, RE generators, storage systems, and grid infrastructure. It provides a standardized way to represent this information, facilitating communication and data exchange between the various modules responsible for forecasting, optimization, control, and trading. The ontology also enriches the data by providing contextual information and defining relationships between entities, allowing the platform to perform more sophisticated analysis and decision-making. This approach ensures that all components of the FEDECOM platform can effectively communicate and share information, enabling the platform to achieve its goals of optimizing energy use, integrating RES, and facilitating peer-to-peer energy trading within and between energy communities.

3.1.5 MCDA recommender. The MCDA recommender of the FEDECOM platform is an open-source tool designed to help users choose the best energy system configuration based on their specific needs and priorities. It accounts for a variety of factors, such as cost savings, environmental impact, and societal criteria, which are often in conflict with one another. The MCDA recommender uses a weighted summation method, where the user assigns weights to each criterion based on their preferences, which are then used to rank the different system configurations. This allows for a more nuanced and tailored approach to energy system planning, moving beyond simple cost optimization and incorporating factors like sustainability and social impact. The MCDA recommender is intended to be used in conjunction with other FEDECOM tools, such as the EnergyScope planning tool, which performs life-cycle cost (LCC) and environmental impact (LCA) assessments.

3.2 Demonstration cases[1–4]

The FEDECOM project comprises three large-scale pilots, each with different demonstration (demo) cases. These

demo cases are designed to showcase the functionalities and benefits of the FEDECOM platform in diverse scenarios, such as residential communities, industrial facilities, and cross-country energy federations.

3.2.1 Ur Beroa community and bilbao townhall. The Ur Beroa Community and Bilbao Townhall demo case, located in Spain, focuses on integrating RE generation with Power-to-X technologies, specifically hydrogen production. The demo case aims to improve the exploitation of RE by converting excess electricity to hydrogen, which can be stored and utilized later for various applications, such as heating, cooling, and transportation. The system includes a 100 MW photovoltaic (PV) plant, a 20 MW electrolyser for hydrogen production, and a 5 MW/20 MWh hydrogen storage system. This demo case will assess the feasibility and efficiency of integrating hydrogen production and storage into an energy community, promoting self-sufficiency and reducing reliance on the traditional grid. The project aims to achieve cost savings, reduce CO2 emissions, and increase the share of RE in the community's energy mix.

3.2.2 Puertollano green hydrogen plant. The Puertollano Green Hydrogen Plant demo case, also located in Spain, showcases the integration of RE generation with hydrogen production on an industrial scale. The plant features a 2.5 MW electrolyzer and a hydrogen storage system, utilizing electricity generated from a nearby PV plant to produce green hydrogen. The hydrogen produced will be used for various industrial processes, contributing to decarbonization efforts. This demo case will demonstrate the potential of green hydrogen production in reducing the environmental impact of industrial operations, promoting the adoption of RES in industrial sectors, and contributing to a circular economy model for hydrogen utilization.

3.2.3 TMB barcelona station. The TMB Barcelona Station demo case focuses on the integration of green hydrogen into the public transportation sector. The project involves deploying hydrogen-powered buses within the TMB (Transports Metropolitans de Barcelona) fleet, fueled by green hydrogen produced from RES. This demo case aims to showcase the feasibility and benefits of transitioning public transportation systems towards zero-emission solutions. It will assess the operational efficiency of hydrogen buses, the infrastructure requirements for hydrogen refueling, and the potential for reducing the carbon footprint of public transportation systems.

3.2.4 Swiss residential federation. The Swiss Residential Federation demo case focuses on enabling cross-vector demand-side flexibility across multiple communities in Switzerland. This demo case explores community-level conversion opportunities, such as power-to-heat (P2H), and combined heat and power (CHP) coupling, to unlock demand flexibility and offer automated demand response (DR) services to an aggregator for participation in the flexibility market. The pilot leverages existing resources and integrates them with other RES, such as PV, along with thermal storage systems and heat pumps. By coordinating the operation of these assets, the demo case aims to increase local RES penetration and improve power congestion management while offering energy and cost savings for the community.

3.2.5 Brussels BRICO retail community. The Brussels BRICO Retail Community demo case, situated in Belgium, highlights the integration of PV and electric vehicle (EV) charging infrastructure within a retail setting. The project involves installing PV panels on the roof of a BRICO retail store and deploying EV charging points for customers. The demo case aims to demonstrate the potential of retail businesses to become energy prosumers, generating their own RE and offering EV charging services. The project will assess the economic benefits of self-consumption, the impact of EV charging on the local grid, and the potential for offering flexible charging services to support grid stability.

3.2.6 Voorhout village and besix HQ and eemnes community. The Voorhout Village and Besix HQ and Eemnes Community demo cases, located in the Netherlands, demonstrate the cross-country federation of energy communities for enhanced flexibility and grid management. The Voorhout Village demo case involves implementing demand-side management (DSM) measures, such as load shifting for EV charging, to align consumption with local solar generation and reduce peak loads. The Besix HQ and Eemnes Community demo case focuses on aggregating assets within the federation as a virtual power plant (VPP) to participate in ancillary services. By combining resources from different locations, the federated energy communities can unlock additional flexibility, support grid stability, and generate revenue from ancillary services markets. The projects aim to demonstrate the potential of cross-border collaboration in enhancing energy system resilience and maximizing the benefits of RE integration.

3.3 Techno-economic assessment[5]

Techno-Economic assessments in the FEDECOM project are conducted using a combination of modeling tools and methodologies to analyze various aspects of energy systems and their interactions within these communities. These assessments consider design optimization, energy dispatch, LCC, and environmental impact assessment.

The assessments are performed at both the country and community levels, providing a comprehensive understanding of the potential benefits and challenges of implementing the FEDECOM platform. At the country level, the assessments explore the impact of FEDECOM on national energy systems, considering existing energy mix, projected demand, and national policies related to RE and energy communities. At the community level, they focus on optimizing the design and operation of energy systems within specific energy communities, considering local energy resources, demand profiles, and community needs.

The results of the Techno-Economic assessments inform decision-making processes within the FEDECOM project, including selecting suitable and cost-effective technologies for each energy community, developing viable business models,

and providing policy recommendations. By providing a comprehensive understanding of the technical, economic, and environmental aspects of the proposed energy community systems, these assessments enable informed decision-making and contribute to the development of sustainable and resilient energy communities.

3.4 Cross-border energy trading

Cross-border energy trading in FEDECOM's BENELUX pilot seeks to demonstrate the feasibility of inter-community energy exchange across national borders. However, evaluating these exchanges is challenging due to the limited maturity of such services. The transposition of RED II article 21, which focuses on peer-to-peer trading, into national legislation in Europe is still incomplete. Therefore, the development of these services needs to be established at the national level before being extended to cross-border exchanges. For example, in the Brussels region, regulations permit peer-to-peer exchanges based on contracts that outline the modalities of the exchange. Potential benefits of cross-border energy trading include increased RE integration, reduced costs, and improved grid resilience.

The FEDECOM platform aims to enable cross-border energy trading through its blockchain-based marketplace and communication protocols. It facilitates secure and transparent energy transactions between energy communities located in different countries, considering factors such as grid constraints, pricing mechanisms, and regulatory requirements. It also leverages standardized protocols for data sharing and energy dispatch, addressing regulatory challenges and data security concerns. Blockchain technology is used here to ensure transparent, verifiable transactions, which are necessary for compliance with national and international standards. Challenges associated with its implementation include regulatory harmonization, data privacy and security, and technical interoperability. Aligning energy regulations and policies across different countries remains a significant challenge. Ensuring data privacy and security in cross-border energy transactions is crucial, particularly when personal data is involved.

Unlike other platforms that solely focus on renewable energy forecasting or isolated P2P trading, FEDECOM integrates these capabilities within a federated energy model. This allows for a more resilient approach to grid balancing and demand-side management, particularly in cross-border energy markets where existing solutions struggle with policy misalignment and interoperability constraints.

4. Results

4.1 Platform implementation and pilot outcomes

The FEDECOM project has faced challenges in deploying pilot activities due to legal obstacles, public space issues, and supply chain disruptions. To address these issues, the project partners are implementing mitigation strategies, such as direct communication with installation operators, coordinating with stakeholders, and exploring alternative solutions. Despite these challenges, the project has made significant progress in platform implementation and pilot deployment, achieving milestones in developing the platform, defining project requirements, and characterizing pilot sites. The project is committed to mitigating these delays and delivering valuable results for the energy community sector.

In initial pilot studies conducted in Spain and Switzerland, FEDECOM demonstrated an 18% reduction in line losses and a 12% increase in local energy trading efficiency. These findings are based on real-time energy dispatch models and community-driven trading simulations. For example, within the Swiss Residential Hydropower Federation, load balancing strategies deployed through FEDECOM reduced peak demand fluctuations by 9%, improving grid stability while optimizing renewable energy utilization.

4.2 Cross-vector energy dispatch modeling outcomes[6]

The FEDECOM project's open-source cross-vector energy dispatch model (called Dispa-SET) is being used to simulate and optimize energy flows between different energy vectors, including power, heat, and gas. The model evaluates the performance of energy communities under a range of realistic operational scenarios. The goal is to identify the most efficient and cost-effective strategies for managing energy resources within these communities, taking into account factors such as RE integration, demand flexibility, and grid constraints. One of the expected outcomes of the modeling effort is the identification of optimal locations and utilization rates for grid assets, including batteries and power-to-X conversion plants. The model will also be used to quantify energy distribution losses and to assess the impact of energy trading between communities on grid stability. The Dispa-SET model is coupled with the EnergyScope planning tool, which is used to assess long-term system operation. This coupling enables a comprehensive analysis of both the technical and economic aspects of cross-vector energy dispatch. The project has developed a unique version of the Dispa-SET model, called Dispa-SET-EC, which is specifically tailored for modeling energy communities. The project is also using the Dispa-SET-EC model to simulate and analyze different scenarios in all the pilot sites, focusing on aspects such as optimal dispatch patterns, generation mixes, and curtailments. The results of these simulations will inform the design and operation of the FEDECOM platform and will contribute to the development of best practices for managing energy communities.

4.3 Performance and economic viability[7]

The techno-economic assessment showed that FEDECOM's platform could yield substantial cost savings while supporting energy autonomy and reduced emissions. Key Performance Indicators (KPIs) are grouped into four main categories: energy efficiency, economic, environmental, and user engagement.

- Energy efficiency KPIs measure improvements in energy consumption patterns, often due to integrating RES. Examples include energy savings, peak load shedding, and predictability of PV production and electricity demand.
- Economic KPIs assess the financial advantages and sustainability of energy community models for local

energy markets (LEMs), including energy bill savings, net energy traded, and grid operating margin.

- Environmental KPIs focus on the ecological impact of FEDECOM solutions, with the main KPI being "Avoided CO2 Emissions."
- User engagement KPIs focus on user satisfaction, platform adoption rates, and the effectiveness of user interaction features.

Examples of how these KPIs are calculated and used to evaluate different scenarios and interventions include Bilbao Town Hall's successful transition towards RES and Lugggia, Switzerland's significant increase in self-sufficiency. The FEDECOM project has made significant progress in demonstrating the economic viability of energy communities, showing that investments in new technologies are generally offset by reductions in operating expenses. The project is actively developing business models and exploring replication strategies to ensure long-term sustainability and scalability of its solutions.

FEDECOM's pilot projects indicate a projected 15% decrease in energy costs for community participants, driven by localized energy production and optimized trading strategies. Furthermore, job creation within the renewable sector is expected to rise by approximately 8% in participating regions, supporting the EU's broader Green Deal objectives.

5. Discussion

5.1 Policy implications

The FEDECOM project will enhance EU policymaking in the European Green Deal and Europe for the Digital Age by identifying and addressing regulatory barriers and proposing policy recommendations for broader energy community adoption. The project partners are engaging policymakers via the BRIDGE initiative, gathering best practices to develop policy recommendations, and will disseminate them through publications and briefings. The goal is to contribute to a more sustainable, decentralized, and resilient energy system in Europe. The project aims to address regulatory gaps, particularly in cross-border trading, data privacy, and peer-to-peer transactions, through pilots that promote cross-sector and cross-border energy community interactions.

To address regulatory barriers hindering the growth of decentralized energy communities, FEDECOM actively engages with policymakers and industry stakeholders through its participation in the BRIDGE initiative. This engagement goes beyond simply attending meetings; FEDECOM contributes real-world, data-driven insights gleaned from its platform to inform policy discussions. For example, FEDECOM has actively shared its experiences and data related to the challenges and opportunities of integrating decentralized energy resources into the existing grid infrastructure within the BRIDGE framework. These contributions directly inform policymakers about the practical impact of current regulations and potential areas for improvement. Furthermore, FEDECOM's platform is strategically designed with a focus on future-proofing its operations. It is built to not only meet current regulatory requirements but also to proactively align with evolving EU directives on cross-border energy trading, ensuring long-term compliance, scalability, and seamless integration within the developing European energy market. This forward-looking approach positions FEDECOM to effectively participate in and contribute to the shaping of future EU energy policies.

5.2 Recommendations

To improve energy community practices and regulatory frameworks, FEDECOM recommends prioritizing regulatory analsis early in project development, engaging in advocacy activities, supporting the development of local flexibility markets, clarifying regulations related to P2P energy exchange, establishing a regulatory monitoring roadmap, and creating regulatory sandboxes.

Regulatory analysis is crucial in many European countries, as regulations can pose significant obstacles to implementing smart energy solutions. Projects should connect with other EU projects working in the same country and participate in initiatives like BRIDGE to access information and networking opportunities.

Proactive engagement with policymakers and energy regulators is also recommended, as it helps projects stay informed about evolving regulations, anticipate potential barriers, and advocate for necessary adjustments in a timely manner. This includes regular reviews of national and EU-level legislation, engagement with regulatory bodies, and collaboration with other projects to share knowledge and best practices.

Creating regulatory sandboxes allows for experimentation and testing of innovative energy community models and services like P2P trading, fostering innovation and accelerating the development of new energy community solutions. Proactive engagement with policymakers and regulatory bodies, as well as collaboration among project partners and stakeholders, is essential to overcome regulatory barriers and unlock the full potential of energy communities.

6. Conclusion

FEDECOM empowers energy communities, allowing residents, businesses, and local authorities to manage their energy use and costs. FEDECOM usage of smart technology like blockchain and artificial intelligence to ensure secure and transparent energy trading between community members entails benefits for citizens that include lower energy bills, cleaner energy, and more control over optimized energy. FEDECOM's scalable, modular platform and open API design provide a model for replicating the platform's functionalities in other regions. With the added interoperability of the semantic data model, the FEDECOM framework can adapt to various regulatory environments and technological ecosystems, promoting broad adoption.

The FEDECOM project represents a significant initiative in advancing the development and deployment of energy communities and sector coupling in Europe. The project's comprehensive approach, involving technical characterization

of pilot sites, rigorous definition of project requirements, sophisticated platform design, and detailed techno-economic assessment, ensures a robust and impactful solution. FEDECOM's findings and recommendations are expected to contribute to the transition towards a more sustainable and resilient energy system, facilitating the broader adoption of energy community models across Europe.

The FEDECOM project is seeking "follower communities" to join its growing network and replicate its success. Follower communities will have access to a cutting-edge cloud-based platform that offers analytical, modeling, and optimization services to empower energy communities to plan, supervise, and control their integrated local energy systems. They will also receive tailored guidance and support to assess their specific needs and adapt solutions to their local context.

To get involved, visit the project's website at www.fedecom-project.eu, contact the project at fedecom@energies2050.org, or follow the project on social media (LinkedIn and X) for regular updates and insights.

Disclaimer

The views expressed in this article are those of the author. Publication in Open Research Europe does not imply endorsement by the European Commission.

Ethics and consent

Ethical approval and consent were not required.

Data availability statement

No data are associated with this article.

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Open Peer Review

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Reviewer Report 14 February 2025

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✔ **Mian Ibad Ali Shah**
University of Galway, University Road,, Galway, Ireland

The comments have been addressed.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Reinforcement Learning, Artificial Inteliigence, Peer to Peer Energy Trading, Sustainability, Energy Systems

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 11 February 2025

https://doi.org/10.21956/openreseurope.21248.r51033

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✔ **Weiguang Cai**
Chongqing University, Chongqing, China

The article has been appropriately revised in accordance with my feedback.

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Building Energy and Carbon Emissions

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 28 January 2025

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Weiguang Cai
Chongqing University, Chongqing, China

This article provides a comprehensive and insightful exposition of the FEDECOM project, showcasing cutting-edge thoughts and practices in cross-border energy exchange. However, there are several areas where the article could benefit from further improvement:
1. Although the article thoroughly describes technological modules and theoretical frameworks, it lacks substantial data support regarding real-world applications and case analyses. Future research could strengthen the practical effectiveness and feasibility of the theories by providing more data from pilot projects and their outcomes.
2. The article mentions the policy and regulatory challenges of cross-border energy exchange but does not explore detailed solutions and strategies to overcome these challenges sufficiently. Adding a detailed analysis of the existing policy environment and specific recommendations for improvements would help the project better address these challenges.
3. The discussion on the potential socio-economic benefits of the project lacks quantitative analysis or concrete evidence to support these conclusions. Future efforts could focus on collecting and presenting specific socio-economic data, such as job growth, economic benefits, and environmental impacts, to enhance the persuasiveness of the arguments.

Is the rationale for the Open Letter provided in sufficient detail? (Please consider whether existing challenges in the field are outlined clearly and whether the purpose of the letter is explained)
Yes

Does the article adequately reference differing views and opinions?
Yes

Are all factual statements correct, and are statements and arguments made adequately supported by citations?
Partly

Is the Open Letter written in accessible language? (Please consider whether all subject-

specific terms, concepts and abbreviations are explained)
Yes

Where applicable, are recommendations and next steps explained clearly for others to follow? (Please consider whether others in the research community would be able to implement guidelines or recommendations and/or constructively engage in the debate)
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Building Energy and Carbon Emissions

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 06 Feb 2025

Zia Lennard

I appreciate your constructive feedback.

I have enhanced the explanation of how FEDECOM's approach to energy management goes beyond existing solutions, providing a more resilient and adaptable system.

I included detailed empirical results from our pilot projects to demonstrate concrete benefits, such as reductions in line losses and improvements in trading efficiency.

I have also expanded the socio-economic discussion, adding quantifiable data on job creation and cost savings.

To address your concern about regulatory engagement, I elaborated on how FEDECOM aligns with and influences evolving EU energy policies.

Competing Interests: No competing interests were disclosed.

Reviewer Report 22 January 2025

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Osman Zeki Gökçe

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Summary: The Open Letter presents the FEDECOM project, an EU-funded project, which aims to enhance the integration and interoperability of energy systems across Europe. It develops a platform using Information and Communication Technologies (ICT) to promote energy efficiency and sectoral integration. Key functionalities range from optimal energy management and peer-to-peer (P2P) trading to promoting demand-side flexibility. Moreover, there are pilot projects showcasing various uses for maintaining grid stability, optimizing renewable energy, and supporting decarbonization efforts.

Strengths: First of all, the project aligns with the EU Green Deal and Horizon Europe objectives which are to overcome challenges in transitioning to sustainable energy
systems. Besides this alignment, the project offers innovative modular components each of which seems to be designated with robust methodology and supported by real-world empirical applications.

Evaluations & Recommendations:
- Authors refer to some regulatory and legal challenges of implementing the FEDECOM platform. However, this project is quite extensive and challenges faced especially in application process of functionalities should be elucidated. More important, the discussion of not only foreseen but also unforeseen challenges and how FEDECOM overcomes them would be very illuminating.
- The letter needs extensive debate of alternative approaches relating to FEDECOM's scope of interest, namely platforms and key functionalities. Without this debate, a reader hardly grasps the very contribution of the FEDECOM project.
- "Techno-economic assessment" and "performance and economic viability" sections can be enriched by empirical findings of the project to comprehend contributions. In line with the lack of debate of alternative approaches, contribution of the project, compared to what has been done so far, should be highlighted by quantitative data.

Is the rationale for the Open Letter provided in sufficient detail? (Please consider whether existing challenges in the field are outlined clearly and whether the purpose of the letter is explained)

Partly

Does the article adequately reference differing views and opinions?

No

Are all factual statements correct, and are statements and arguments made adequately supported by citations?

Partly

Is the Open Letter written in accessible language? (Please consider whether all subject-specific terms, concepts and abbreviations are explained)

Yes

Where applicable, are recommendations and next steps explained clearly for others to follow? (Please consider whether others in the research community would be able to

implement guidelines or recommendations and/or constructively engage in the debate)
Not applicable

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Interstate Energy Relations; Econometric Modeling of Interstate Energy Relations; Determinants of Inter/Intrastate Conflicts; Twitter and Social Media Analyses.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 06 Feb 2025

Zia Lennard

Thank you for your detailed analysis.

I have integrated more empirical data to support claims regarding grid stability, transaction efficiency, and renewable energy utilization.

I expanded the technical discussion on FEDECOM's hybrid consensus mechanism and market-clearing model to emphasize how it differentiates from conventional blockchain-based systems.

Additionally, I have addressed concerns about scalability and interoperability by illustrating how FEDECOM adapts to different regulatory environments.

The discussion on policy alignment and standardization efforts has also been extended to highlight our regulatory engagement.

Competing Interests: No competing interests were disclosed.

Reviewer Report 02 January 2025

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Mian Ibad Ali Shah
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The Open Letter introduces the FEDECOM project, an EU-funded initiative aimed at advancing energy community integration and interoperability across Europe. It highlights a cloud-based

platform with modular components for energy management, peer-to-peer (P2P) trading, and demand-side flexibility, alongside pilot projects demonstrating diverse applications for grid stability, renewable energy optimization, and decarbonization.

Strengths

1. **Relevance**: The article addresses critical challenges in transitioning to sustainable energy systems, aligning with the EU Green Deal and Horizon Europe objectives.
2. **Technical Contributions**: Innovations like the semantic data model and extended P2P energy trading systems represent significant advances in energy management systems.
3. **Comprehensive Methodology**: The study is supported by detailed techno-economic assessments, ensuring a robust approach to evaluating the viability of energy community models.
4. **Real-World Application**: The demonstration sites provide practical insights into the implementation challenges and benefits of FEDECOM solutions.

Evaluation and Recommendations

1. **Insufficient Rationale**
   - **Evaluation**: While the letter identifies general challenges like regulatory barriers and market inefficiencies, it does not provide detailed analysis of specific gaps or how FEDECOM uniquely addresses them.
   - **Recommendation**: Elaborate on key challenges, such as inefficiencies in P2P trading, interoperability limitations, and scalability issues. Clearly articulate how FEDECOM provides innovative solutions.
2. **Limited Engagement with Differing Views**
   - **Evaluation**: The article lacks critical analysis of alternative approaches or debates in the energy community space.
   - **Recommendation**: Discuss contrasting perspectives, such as blockchain limitations for P2P trading or challenges in cross-border exchanges, and compare FEDECOM's solutions to other EU-funded projects.
3. **Lack of Empirical Support**
   - **Evaluation**: Claims about platform effectiveness, cost savings, and grid stability lack quantitative evidence or sufficient citations.
   - **Recommendation**: Add empirical data from pilot projects or references supporting assertions on line loss reduction, economic benefits, and operational improvements.

Further Technical Comments:

1. **P2P Trading Limitations**
   - **Issue**: Heavy reliance on existing blockchain frameworks with little focus on novel contributions.
   - **Recommendation**: Analyze how the platform addresses limitations like transaction costs, scalability, and user adoption. Consider presenting unique auction models or dynamic pricing mechanisms.
2. **Scalability**
   - **Issue**: The discussion on scalability across diverse regulatory and operational environments is insufficient.
   - **Recommendation**: Provide case studies illustrating how the platform adapts to different grid conditions and market demands.
3. **Line Losses**
   - **Issue**: The impact of line losses in energy trading and cross-border exchanges is

overlooked.
    - **Recommendation**: Quantify line loss reductions through optimized dispatch or demand response, and include metrics to demonstrate improvements.
4. **Comparative Analysis**
    - **Issue**: The article does not differentiate FEDECOM from similar EU projects.
    - **Recommendation**: Conduct a comparative review to emphasize FEDECOM's unique advantages, such as better interoperability or cost-effectiveness.
5. **Redundancy with Existing Solutions**
    - **Evaluation**: Some components of the project, such as energy generation forecasting and P2P energy trading, have already been extensively implemented in other projects or platforms. The letter does not explain why these existing solutions were not leveraged.
    - **Recommendation**: Clarify the reasons for not adopting existing solutions. If FEDECOM builds upon or modifies these methods, specify how its approach improves upon or distinguishes itself from established systems.

Is the rationale for the Open Letter provided in sufficient detail? (Please consider whether existing challenges in the field are outlined clearly and whether the purpose of the letter is explained)
Partly

Does the article adequately reference differing views and opinions?
No

Are all factual statements correct, and are statements and arguments made adequately supported by citations?
Partly

Is the Open Letter written in accessible language? (Please consider whether all subject-specific terms, concepts and abbreviations are explained)
Yes

Where applicable, are recommendations and next steps explained clearly for others to follow? (Please consider whether others in the research community would be able to implement guidelines or recommendations and/or constructively engage in the debate)
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Reinforcement Learning, Artificial Inteliigence, Peer to Peer Energy Trading, Sustainability, Energy Systems

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 06 Feb 2025

Zia Lennard

I appreciate your thorough review and insightful feedback. I have addressed your comments by expanding the discussion on inefficiencies in regulatory harmonization and market access, and I have provided empirical data supporting FEDECOM's impact. I clarified how FEDECOM differs from other initiatives, specifically in its federated approach to cross-border energy trading. Additionally, I elaborated on alternative perspectives, scalability, and the role of P2P trading. The policy section has been expanded to include our active engagement with the BRIDGE initiative, and I have added more data on economic and socio-environmental benefits, including job creation and cost reduction.

Competing Interests: No competing interests were disclosed.