sciendo

LATVIAN JOURNAL OF PHYSICS
AND TECHNICAL SCIENCES
2024, N 3

DOI: 10.2478/lpts-2024-0020

EVOLVING CONCEPT OF ENERGY COMMUNITIES IN THE EUROPEAN UNION

M. Auders*, S. Lapuke

Riga Technical University,
Faculty of Engineering Economics and Management,
6 Kalnciema Str. 210, Riga, LV-1048, LATVIA
*e-mail: martins.auders@edu.rtu.lv

In accordance with the goal approved by the Council of the European Union, a European climate-neutrality must be achieved by 2050. Namely, the European Union must significantly reduce greenhouse gas emissions and find ways to compensate for the remaining and unavoidable ones. Within the framework of the European Green Deal, which is a set of policy initiatives to achieve climate neutrality goals, energy communities are considered in the context of two initiatives: a just transition and clean and safe energy at an affordable price. Within the latter, energy community is seen as citizen-led actions in the energy sector that will help pave the way for the transition to clean energy.

Keywords: *Energy community concept, legal framework, renewable energy, terminology.*

1. INTRODUCTION

In accordance with the goal approved by the Council of the European Union, a European climate-neutrality must be achieved by 2050. It means that, by the year 2050, the European Union (EU) must significantly reduce greenhouse gas (GHG) emissions and find ways to compensate for the remaining and unavoidable emissions. Within the framework of the European Green Deal, which is a set of policy initiatives to achieve climate neutrality goals, energy communities (EC) are considered in the context of two initiatives: a just transition and clean and safe energy at an affordable price. Within the latter, EC are seen as citizen-led actions in the energy sector that will help pave the way for the transition to clean energy.

With the emergence of alternative energy sources and the ability to generate electricity using more readily available primary energy sources (i.e., solar radiation, wind energy, geothermal heat, renewable gases etc.), it is possible to move towards

a more decentralised energy production scheme. This differs from the traditional scheme with a limited number of participants, where energy is transported over long distances from large production centres. According to the policy makers of the EU, the introduction of the EC concept is the way to restructure the energy system, thus allowing citizens to actively participate in the energy transition and, as energy consumers and prosumers in residential homes, to enjoy greater sustainability benefits.

2. THE ORIGIN OF THE ENERGY COMMUNITY CONCEPT: LITERATURE REVIEW

The origins of EC in Europe can be traced back to the 1970s and 1980s in Sweden, the Netherlands, and Denmark, with later developments in Germany, the United Kingdom, and other countries. Initially, these communities focused on the production of renewable energy – both electricity and heat supply. Thousands of initiatives around the world can now be considered to address EC, highlighting the global reach and adoption of this concept [1].

However, it is only in the last decade that research on this topic expanded significantly [2]. EC also appear under such terms as "community energy initiatives (projects)" and "energy cooperatives" [3], renewable energy communities [4], smart energy communities [2], prosumer communities [5], citizens energy communities [6] and other.

In the literature, it has been presumed that the term "energy community" is controversial and can raise a series of questions [1]. There are authors who focus on typology of energy communities, while others concentrate on geographical and local trends, and communities as small businesses, or communities as owners of energy infrastructure [1].

De São José et al. [2] believe that the energy community is one of the types of smart energy communities, and, referring to Barbour et al. [7], and Gorroño-Albizu et al. [8], an energy community: "…is a community of producing consumers that shares or sells energy within the community or to the grid." De São José et al. [2] have also listed other types of smart energy communities, including smart building communities (building clusters), renewable energy communities, and other communities that could be classified as energy communities. Regarding the term "energy community", they expressed the opinion that given the possibility of various forms of energy communities, a unifying term is needed to encompass these diverse manifestations.

Wirth [9] views community energy projects as local residents' involvement in various renewable energy initiatives, for example, in the context of wind energy, where large-scale wind parks do not gain local community support, whereas community-scale projects enjoy widespread public support. At the same time, this author also points out that the term "community" is not clear and unambiguous, and, therefore, it should be clarified [9].

Eagle and Jones believe that in most academic studies and literature, almost no analysis is directed towards determining what "community" means [10]. These authors also associate community energy initiatives with localism, which is contrasted with globalisation and described as a movement to reclaim sovereignty over the local economy in the era of globalisation [10].

In the urban context, the concept of "community" is understood as a specific geographical area characterised by similar physical properties and a network of social ties. The size of a community is not fixed, and it can range from a group of physically similar buildings to an area nearly the size of a district, which includes various uses but is unified by a common identity [11].

Residents have different energy consumption needs, including comfort temperature [12]. Walker and Devine-Wright [13] examine community energy projects according to two dimensions: process and outcomes. The process dimension refers to the need for significant local resident involvement in planning, creation, and possibly project management. The outcome dimension concerns the benefits of the project and how they are distributed among local residents.

Moroni et al. [2] have provided the following classification of communities related to energy:

- communities not related to a specific location. Such a community does not require a geographical connection, therefore, its members can join in various ways;
- communities related to a specific location. They can be located in a single building, including apartment properties in a building, a neighbourhood, or a city. They may have the advantage of using the same network, short transmission distance for shared electricity, and other aspects related to physical distance; moreover, they can help achieve various local objectives;
- single-purpose communities. Communities that are established for only one purpose – to manage energy production, consumption, or procurement;
- multi-functional communities. In addition to energy objectives, these communities can also share other types of goods or services [2].

Although Moroni et al. have classified communities not related to a specific location, there are authors who believe that EC can be formed by consumers, producers, and prosumers located in a specific geographical area [14]. On the other hand, Barbour et al. [7] are not so strict regarding a specific location, as their proposed definition of energy communities suggests that the community is usually (but not exclusively) related to a specific location.

3. THE CONCEPT OF ENERGY COMMUNITY IN THE CONTEXT OF THE OBJECTIVES SET BY THE EU

Many authors also associate the concept of EC with the objectives of the European Union. For instance, Amato et al. [15] point out that Europe has set an ambitious goal to become the first carbon-neutral continent by 2050. Therefore, it has undertaken several initiatives to promote the transition in the energy sector, including the active participation of citizens in the energy industry. According to the authors, the concept of EC has been introduced in the European directives so that community members can consume, share and store locally produced energy [15]. Other authors have expressed a similar opinion, namely, that the concept of EC allows prosumers to utilise locally produced energy and reduce the need for external energy deliveries.

This can lead to significant cost savings and increase the percentage of green energy [16], as well as provide an opportunity for alternative energy system organisation and management methods in the future: smart

energy transmission, distribution and metering [17], [18], digital twinning, introduction of green energy sources, for example, gases, in conventional energy distribution and transmission networks [19]–[22]. In future, it could also help minimise impact of energy delivery disruptions during local energy crisis that could occur in practically every centralised and extended energy delivery network [23].

It must also be pointed out that, under the Electricity Market Directive, the EU members have the option to grant EC the right to own, establish, purchase or lease a grid infrastructure. They can be engaged in network operations either under the general regime (public grid) or as closed distribution system operators.

Once an EC is granted the status of a distribution system operator (DSO), it is subject to the same rights and obligations as other kinds of DSO. These include unbundling rules and the related exemptions for DSOs that serve less than 100 000 final customers.

Other authors believe that energy communities will provide end-users with democratic, open access to the network and collective self-consumption. Some again argue that EC will provide end-users with democratic, open access to the network and collective self-consumption. They will promote decentralisation and foster the use of distributed renewable energy sources [24], [25].

Cuenca et al. [14] associate EC with the concept of the sharing economy and express the view that an energy community is defined as a community-driven institution that takes social control over common energy resources through decentralisation.

Similarly, it is visible in the literature that the concept of EC needs to be defined in legislation to engage the public in energy production, and the definition of EC is also mentioned in connection with the rights of prosumers [26]. A similar view has been expressed by Aruta et al. [27], pointing out that residents need to transform from being passive consumers to active prosumers, becoming part of an EC.

In order to extend the life cycle of buildings and to ensure the comfort of every building user, it is necessary to provide the managed property with quality management and maintenance services and organise maintenance properly [12].

Peer-to-peer trading as a form of energy sharing within energy communities has been mentioned by Ciobanu et al. [28]. Meanwhile, Löbbe et al. [29], as well as Hahnel et al. [30], have examined peer-to-peer trading within energy communities in more detail [30]. Despite the consensus among researchers that the essence of the EC concept is to decentralise energy production by involving residents, as believed by de Almeida, Cappelli, Klausmann, and van Soest [31], there is still ongoing debate between researchers and policymakers about what kind of decentralised energy exchange is associated with peer-to-peer trading and what kind is associated with an EC, resulting in many conflicting definitions. This is also due to the fact that before the introduction of the Clean Energy Package in the EU legislation, the term "community" was not used consistently, thus leading to ambiguity in scientific publications and policy debates.

4. ANALYSIS OF THE EU REGULATION

The reference that not every "energy community" is considered an energy community according to European Union regulations stems from the European Parliament and Council Directive (EU) 2019/944 on common rules for the internal market for

electricity, amending Directive 2012/27/EU, consideration 43, which clarifies that this directive recognises only certain categories of pre-existing resident electricity initiatives at the Union level as "citizen energy communities". However, despite such a reference in the directive, this aspect has not been given due attention in the literature, and there is hardly any analysis of the EU regulation in publications.

An exception is the article by de Almeida et al. "Peer-to-Peer Trading and Energy Community in the Electricity Market – Analysing the Literature on Law and Regulation and Looking Ahead to Future Challenges". In this article, the authors indicate that, according to the EU regulation, the following models related to decentralised energy exchange can be distinguished:

- individual self-consumption;
- collective self-consumption;
- peer-to-peer trading;
- ECs.

Compliance with established EU regulation on building energy, energy efficiency is relevant for each country's economy and is one of the national priorities [32].

If there are no fundamental disagreements in the literature about distinguishing collective self-consumption from energy communities, then peer-to-peer trading within the framework of energy communities is examined in the works of many authors. As Almeida et al. [31] point out, Directive (EU) 2019/944 simultaneously uses the terms "peer-to-peer trading" and "renewable energy sharing within a renewable energy community", thereby distinguishing these models from each other in the directive. Therefore, Almeida et al. [31] believe that the European Union has adopted a definition that strives to be inclusive, but at the same time, understands peer-to-peer trading differently from the model described in most of the literature.

Examining the European Parliament and Council Directive (EU) 2019/944, it is apparent that a "citizen energy community" is defined as a legal entity that can engage in production, including from renewable resources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services provision, electric vehicle charging services, or provide other energy services to its members or shareholders. Thus, an EC can engage in both energy production and aggregation.

In contrast, peer-to-peer trading with renewable energy is the trade of renewable energy between market participants through a contract with predefined rules that regulate the automatic execution and settlement of the transaction either directly between market participants or indirectly through a certified third market participant, such as an aggregator. Hence, it can be concluded that "peer-to-peer trading" is possible through an EC acting as an aggregator.

However, an EC as an energy producer and an EC as an aggregator represent two distinct operational areas of an EC. In the first case, it involves the production and collective use of renewable energy produced by the community's own production facilities for its members or participants (see European Parliament and Council Directive (EU) 2018/2001). In the second case, the EC has an aggregator function, where through the energy community as an aggregator, the trade of renewable energy produced by active users, who are members of the energy community, takes place. This aligns with the provision in Article 16 of the European Parliament and Council Directive (EU) 2019/944, stating that members or shareholders of a citizen energy community do not lose their rights and responsibilities as household users or active users.

Therefore, a person who has joined an

energy community can have two different roles: they can be a member of the EC, supplied with electricity from production stations within the community, and also an active user who uses the energy community as an aggregator in a peer-to-peer trading model.

5. CONCLUSION

The study of the EC concept is problematic for several reasons. First, different terms are used in scientific literature to denote the same concept. For example, the term "energy community," "energy cooperative," and "community energy project" may all signify essentially the same initiative by residents in the field of energy. Second, the term "energy community" can also be understood to mean conceptually different ideas in various studies.

Regardless of the content of the concept described by the term "energy community", the unifying element is usually the community itself, as well as the goal related to local residents' initiatives in the area of decentralised energy production. Unlike the community's goal, there is a divergent opinion in the literature about the scale of energy communities and their connection to a specific geographical location. Simultaneously, it is entirely possible to agree with the opinion expressed in the literature that there are many conflicting definitions of EC. This is especially significant in discussions about what kind of decentralized energy exchange is associated with peer-to-peer trading and what kind is associated with an EC.

The answer to this question is found by analysing the legal regulation of the EU, namely, the European Parliament and Council Directive (EU) 2019/944 and the European Parliament and Council Directive (EU) 2018/2001. From these legislative acts, it follows that an energy community can have various areas of activity. Among these are the function of an energy producer and the function of an aggregator, which are distinguishable from each other. Therefore, in response to the question of whether a peer-to-peer trading model is possible within the framework of EC, the answer is "yes", but only in relation to the function of the community as an aggregator. Moreover, the energy produced by active users is not considered the energy of the community, i.e., it does not belong to the community.

Conversely, if the question is whether only a peer-to-peer trading model is possible within an EC, without energy production using the community's own production equipment, the answer is "no" because, in such a case, the community will only fulfil an aggregator function.

REFERENCES

1. Moroni, S, Alberti, V, Antoniucci, V, & Bisello, A (2019). Energy Communities in the Transition to a Low-Carbon Future: A Taxonomical Approach and Some Policy Dilemmas. *Journal of Environmental Management*, *236*, 45–53. https://doi.org/10.1016/j.jenvman.2019.01.095
2. De São José, D., Faria, P., & Vale, Z. (2021). Smart Energy Community: A Systematic Review with Metanalysis. *Energy Strategy Reviews*, *36*. https://doi.org/10.1016/j.esr.2021.100678

3. Brummer, V. (2018). Community Energy – Benefits and Barriers: A Comparative Literature Review of Community Energy in the UK, Germany and the USA, the Benefits it Provides for Society and the Barriers it Faces. *Renewable and Sustainable Energy Reviews*, *94*. 10.1016/j.rser.2018.06.013
4. Coenen, F. H. J. M., & Hoppe, T. (2021). Renewable Energy Communities as a New Actor in Home Energy Savings. *Urban Planning*, *7*, 108–122. 10.17645/up.v7i2.5088.
5. Chan, H., Zeng, K. & Yang, Morgan. (2022). Review platforms as prosumer communities: theory, practices and implications. *European Journal of Marketing*, *56.* 10.1108/EJM-10-2021-0819.
6. Wuebben, D., Romero-Luis, J., & Gertrudix, M. (2020). Citizen Science and Citizen Energy Communities: A Systematic Review and Potential Alliances for SDGs. *Sustainability*, *12*, 10096. https://doi.org/10.3390/su122310096
7. Barbour, E., Parra, D., Awwad, Z., & Gonzalez, M.C. (2018). Community Energy Storage: A Smart Choice for the Smart Grid? *Applied Energy*, *212*, 489–497. https://doi.org/10.1016/j.apenergy.2017.12.056
8. Gorroño-Albizu, L., Sperling, K., & Djørup, S. (2019). The Past, Present and Uncertain Future of Community Energy in Denmark: Critically Reviewing and Conceptualising Citizen Ownership. *Energy Research Social Science, 57,* 101231. https://doi.org/10.1016/j.erss.2019.101231
9. Wirth, S. (2014). Communities Matter: Institutional Preconditions for Community Renewable Energy. *Energy Policy*, *70*, 236–246.
10. Eagle, R., & Jones, A. (2017). Localism and the Environment: A Critical Review of UK Government Localism Strategy 2010–2015. *Local Economy, 32* (1), 55–72, https://doi.org/10.1177/0269094216687710
11. Petersen, J.P. (2016). Energy Concepts for Self-Supplying Communities Based on Local and Renewable Energy Sources: A Case Study from Northern Germany. *Sustainable Cities and Society*, *26*. 10.1016/j.scs.2016.04.014
12. Laicāns, M., Amoliņa, I., Geipele, I., Zeltiņš, N., & Greķis, A. (2018), Heat Cost Allocation in Multi-Apartment Buildings: A Literature Review. *Latvian Journal of Physics and Technical Sciences*, *55* (5), 26–35. DOI:10.2478/lpts-2018-0033
13. Walker, G., & Devine-Wright, P. (2008). Community Renewable Energy: What Should it Mean? *Energy Policy, 36*, 497–500. 10.1016/j.enpol.2007.10.019
14. Cuenca, J.J., Jamil, E., & Hayes, B. (2021). State of the Art in Energy Communities and Sharing Economy Concepts in the Electricity Sector. *IEEE Transactions on Industry Applications*. 10.1109/TIA.2021.3114135
15. Amato, A., Ciocia, A., Garello, E., Malgaroli, G., & Spertino, F. (2022). *Hourly Simulation of Energy Community with Photovoltaic Generator and Electric Vehicle*. 10.1109/EEEIC/ICPSEurope54979.2022.9854521
16. Scarcello, L., Giordano, A., Mastroianni, C., & Spezzano, G. (2022). Cascade Computing Model to Optimize Energy Exchanges in Prosumer Communities. *Heliyon*, *8*, e08902. 10.1016/j.heliyon.2022.e08902
17. Savickis, J., Zemite, L., Bode, I., & Jansons, L. (2020). Natural Gas Metering and its Accuracy in the Smart Gas Supply Systems. *Latvian Journal of Physics and Technical Sciences*, *57* (5), 39–50. DOI: 10.2478/lpts-2020-0026
18. Savickis, J., Zemite, L., Zeltins, N., Bode, I., Jansons, L., Dzelzitis, E., … & Ansone, A. (2020). The Biomethane Injection into the Natural Gas Networks: The EU's Gas Synergy Path. *Latvian Journal of Physics and Technical Sciences*, *57* (4), 34–50. DOI: 10.2478/lpts-2020-0020
19. Jansons, L., Bode, I., Zemite, L., Zeltins, N., Geipele, I., & Kiesners, K. (2022). Securing Sustainable Energy Future: Green Hydrogen as a Part of Gaseous Fuel Diversification Risk Management Strategy. *Latvian Journal of Physics and Technical Sciences*, *59* (4), 53–70. DOI: 10.2478/lpts-2022-0033

20. Jansons, L., Silina, J., Bode, Zemite, L., Zeltins, N., & Palkova, K. (2024). Injection of Renewables Gases into the Existing Gas Distribution Grids and Employment of Reverse Gas Flow Technique. *Latvian Journal of Physics and Technical Sciences, 61* (2), 66–79. https://doi.org/10.2478/lpts-2024-00313
21. Zemite, L. Jansons, L., Zeltins, N., Lapuke, S., & Bode, I. (2023). Blending Hydrogen with Natural Gas/Biomethane and Transportation in Existing Gas Networks. *Latvian Journal of Physics and Technical Sciences, 60* (5), 43–55. https://doi.org/10.2478/lpts-2023-00380
22. Savickis, J., Zemite, L., Jansons, L., Bode, I., Dzelzitis, E., Broks, A., & Vempere, L. (2020). The Development of the Smart Gas Distribution: General Trends and the Latvian Context. *Latvian Journal of Physics and Technical Sciences*, *57* (6), 23–39. DOI: 10.2478/lpts-2020-0031
23. Zemite, L., Nevercika, E., Jansons, L., Bode, I., Koposovs, A., Kondrahins, N., & Jasevics, A. (2021). The Natural Gas Supply of the Latvian Municipality during the Local Energy Crisis. *Latvian Journal of Physics and Technical Sciences*, *58* (3), 186–200. DOI: 10.2478/lpts-2020-0025
24. Lazdins, R., & Mutule, A. (2023). Impact of variable factors on the viability and efficiency of energy communities: A scenario simulation study in Latvia. *In IEEE 64th International Scientific Conference on Power and Electrical Engineering of Riga Technical University (RTUCON 2023)*, (pp. 1–5). 9 October 2023, Riga, Latvia. doi:10.1109/RTUCON60080.2023.10413190
25. Di Lorenzo, G., Martirano, L., Araneo, R., Cappello, L., Giorgio Mingoli, G., & Franco Ermellino, F. (2021). Democratic power sharing in renewable energy communities: Engaging citizens for sustainable energy transition. In *2021 IEEE International Conference on Environment and Electrical Engineering and 2021 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)*, (pp. 1–6). 7–10 September 2021, Bari, Italy. 10.1109/EEEIC/ICPSEurope51590.2021.9584606
26. Lebedeva, K., Krumins, A., Tamane, A., & Dzelzitis, E. (2021). Analysis of Latvian Households' Potential Participation in the Energy Market as Prosumers. *Clean Technologies*, *3* (2), 437 –449. https://doi.org/10.3390/cleantechnol3020025
27. Aruta, G., Ascione, F., Bianco, N., Bindi, L., De Rossi, F., & Manniti, G. (2023). From consumers to prosumers: The rise of Energy Communities and their role in the energy transition. In *8th International Conference on Smart and Sustainable Technologies (SpliTech)*, (pp. 1–6). Split/Bol, Croatia. doi: 10.23919/SpliTech58164.2023.10193292
28. Ciobanu, I., Lazaroiu, G.C., & Fulginei, F.R. (2023). Energy community part of smart city. In *2023 IEEE International Smart Cities Conference (ISC2),* (pp. 1–7).
29. Löbbe, S., Hackbarth, A., Stillahn, T., Pfeiffer, L., & Rohbogner, G. (2020). Customer Participation in P2P Trading: A German Energy Community Case Study. *Behind and Beyond the Meter*, 83–104. 10.1016/B978-0-12-819951-0.00004-9
30. Hahnel, U.J.J., Herberz, M., Pena-Bello, A., Parra, D., & Brosch, T. (2020), Becoming Prosumer: Revealing Trading Preferences and Decision-Making Strategies in Peer-To-Peer Energy Communities. *Energy Policy*, *137*. 10.1016/j.enpol.2019.111098
31. De Almeida, L., Cappelli, V., Klausmann, N., & Henri van Soest, H. (2021). *Peer-to-Peer Trading and Energy Community in the Electricity Market – Analysing the Literature on Law and Regulation and Looking Ahead to Future Challenges.* Robert Schuman Centre for Advanced Studies Research Paper No. RSCAS 2021/35. http://dx.doi.org/10.2139/ssrn.3821689 10.13140/RG.2.2.29089.22888
32. Upītis, M., Amoliņa, I., Geipele, I., & Zeltiņš, N. (2020). Measures to Achieve the Energy Efficiency Improvement Targets in the Multiapartment Residential Sector. *Latvian Journal of Physics and Technical Sciences*, *57* (6), 40–52. doi:10.2478/lpts-2020-0032