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Storage for Energy Justice: The Role of Energy Communities in EU Law

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ABSTRACT

Energy storage plays a crucial role in the decarbonization puzzle. Storing electricity facilitates the utilization of intermittent renewable energy sources, ensuring reliable availability while providing key grid services. Serving as a balance between energy supply and demand, storage contributes to the stability of both on-grid and off-grid networks. Moreover, storage can dramatically increase energy justice by 'localizing' sustainability while facilitating the implementation of inclusive policies. In this context, the concept of energy justice expands to encompass increased access to clean, affordable, and democratically managed energy, aligning with the objectives of the Sustainable Development Goals. Notably, within the European Union (EU), legislative frameworks pertaining to storage and energy communities have made considerable strides. However, these advancements have been reactive to distinct challenges, lacking a cohesive approach—notably, one incentivizing storage deployment within energy communities. While energy communities represent hubs of social innovation towards decarbonization, their widespread deployment and financing face regulatory hurdles. These regulatory barriers impede the deployment of renewable energy storage at scale and speed. Consequently, this article delves into strategies for enhancing the scalability of renewable energy storage within energy communities. In the absence of a comprehensive EU storage bill and EU-wide storage targets, this article advocates for a three-point agenda aimed at leveraging opportunities through finance, power, and innovation packages. By doing so, it highlights a unique opportunity to foster energy justice on a broader scale.

KEYWORDS: Energy justice; Storage; Energy communities; Scalability; SDGs

> One citizen differs from another, but the salvation of the community is the common business of them all.
>
> – Aristotle, *Politics*, Book 3, Part 4

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I. INTRODUCTION

In Greek mythology, Aeolus, the god keeper of the winds, would store wind power in a bag to bestow it upon travelers for safe passage home.[1] Similarly, the Greek god Helios would put the sun in a chariot and drive it every day across the sky to harness its power and then rest.[2] The rationale for storing resources for later use dates back to mythological times, serving to compensate for periods when resources are unavailable. In our increasingly renewable energy mixes, storage has become all the more paramount. It enables the utilization of intermittent renewable energy by providing clean electricity when demand is highest. It reduces high prices,[3] energy waste, and dependence on fossil fuels.[4] It is a crucial balance between energy demand and supply at a time of high energy insecurity.[5] However, renewable energy storage capacity is insufficient to enable renewables in competing with fossil fuels.[6] Record increases in installing renewables in 2023 failed to reduce the massive share of fossil fuel energy consumption, amounting to a whopping 84 per cent globally.[7]

In the International Renewable Energy Agency's (IRENA) recent statistics on renewable energy, global pumped storage, which is the most widely deployed storage technology, has increased much less than renewable energy and concomitantly decreased in Europe and North America.[8] Additionally, notwithstanding record battery storage increases worldwide, IRENA's statistics fail to include the most scalable storage technology so far, namely, electric energy storage capacity.[9] Overall, storage can be dubbed one of the missing pieces of the decarbonization puzzle, with ripple consequences on the Sustainable Development Goals (SDGs)—in particular, on progress to affordable, clean energy (SDG 7) by innovating and decarbonizing energy systems (SDG 9) to build sustainable cities and communities (SDG 11) through sustainable production and consumption (SDG 12) for climate resilience and action (SDG 13).[10]

Thirty years ago, we would have not connected barrels and electrons to the word justice. But energy policy raises substantial ethical and legal questions while posing several paradoxes, which are intrinsically connected with the ideal of energy justice.[11] For instance, electric utilities are in principle asked to pursue just and reasonable outcomes, but there is very little knowledge or control on what it entails. There is no understatement about the conflicts

[1] AC Purves, 'Wind and Time in Homeric Epic' (2010) 140 Trans Am Philol Assoc 323 at 334.

[2] C Cooper, *Our Sun: Biography of a Star* (2013) at 105.

[3] C Bene, A Ellerbeck and J Gorenstein Dedecca, 'Solving the Energy Storage Problem for a Clean Energy System' *SDG Action* (7 November 2023) <https://sdg-action.org/solving-the-energy-storage-problem-for-a-clean-energy-system/>.

[4] Y Ryan Li, F Nejabatkhah and H Tian, *Smart Hybrid AC/DC Microgrids: Power Management, Energy Management, and Power Quality Control* (2023) at 21ff <https://doi.org/10.1002/9781119598411>.

[5] J Bordoff and ML O'Sullivan, 'The Age of Energy Insecurity: How the Fight for Resources Is Upending Geopolitics' *Foreign Affairs* (10 April 2023) <https://www.foreignaffairs.com/world/energy-insecurity-climate-change-geopolitics-resources>.

[6] 'Grid-Scale Storage' *International Energy Agency* (accessed 28 April 2024) <https://www.iea.org/energy-system/electricity/grid-scale-storage>; J Larsen 'Storage Is the Key to the Renewable Energy Revolution' *World Economic Forum* (30 August 2023) <https://www.weforum.org/agenda/2023/08/storage-is-the-key-to-the-renewable-energy-revolution/>.

[7] The figures represent percentages of primary energy. See Energy Institute, *Statistical Review of World Energy* (2024) at 6.

[8] The data refer to pure pumped storage only. International Renewable Energy Agency (IRENA), *Renewable Capacity Statistics* (2024) at 12ff <https://mc-cd8320d4-36a1-40ac-83cc-3389-cdn-endpoint.azureedge.net/-/media/Files/IRENA/Agency/Publication/2024/Mar/IRENA_RE_Capacity_Statistics_2024.pdf?rev=a587503ac9a2435c8d13e40081d2ec34>.

[9] Electric energy storage capacity was 18.8 gigawatts in 2022. 'Cumulative Electric Energy Storage Capacity Worldwide from 2015 to 2022' *Statista* <https://www.statista.com/statistics/1399101/electric-energy-storage-capacity-worldwide/>.

[10] Bene, Ellerbeck and Gorenstein Dedecca, *supra* note 3; F Cappellaro et al, 'Implementing Energy Transition and SDGs Targets throughout Energy Community Schemes' (2022) 8 J Urban Ecol 1 at 2 <https://doi.org/10.1093/jue/juac023>.

[11] BK Sovacool and MH Dworkin, 'Energy Justice: Conceptual Insights and Practical Applications' (2015) 142 Appl Energy 435 <https://doi.org/10.1016/j.apenergy.2015.01.002>.

that can emerge between 'green' and 'just,' as is evident by the stark inequities in clean energy initiatives.[12] It is still surprising, however, that the energy agenda rarely includes the justice dimensions of energy storage. This gap is especially notable given that energy storage plays a crucial role in enabling the broader adoption of renewable energy—an essential shift in addressing the energy sector, which is one of the primary contributors to the climate crisis.[13] Replacing natural gas-fired peaking-power plants with battery storage can in fact increase clean air, health outcomes, and reduce energy burdens.[14]

In this context, energy justice can be defined as the 'goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those historically harmed by the energy system.'[15] Energy communities have emerged as a solution to decarbonize, democratize, and increase fairness in energy systems from a multidisciplinary perspective.[16] The legal artifact of energy communities is poised to increase the economic, environmental, and social participation in the energy systems of all communities, especially front-line communities that are disproportionately impacted by the currently dominant extractive energy systems.[17] Legal directions have emerged in bits and pieces, without embedding storage enablers within energy community legislation and only at a comparative level, thus requiring a more comprehensive take.

This article focuses on European law in order to investigate energy storage as a future-proof enabler of energy justice in the context of energy communities. This focus is due to the current lack of clarity on storage regulatory frameworks to meet the European Union's (EU) need for energy storage capacity, as derived from its 2030 (200 gigawatts) and 2050 (600 gigawatts) projection,[18] and how such capacity would be fulfilled by different technologies and different actors. The overall objective is to enhance the scalability of renewable energy storage within energy communities. The article proceeds as follows: After delving into the concept of community energy, it puts forward an integrated legal agenda for embedding renewable energy storage enablers within energy communities, starting with the EU. Accordingly, the article proposes a three-point agenda aimed at leveraging opportunities for storage in energy communities through finance, power, and innovation packages. The ultimate result is a multi-instrumental approach to polycentric energy governance.

The article is premised on several assumptions and limitations. First, the three-point agenda cannot possibly include all aspects of energy storage regulation. However, the agenda's general character has several advantages as it may work across jurisdictions for increasing energy storage

[12] In general, see P Villavicencio Calzadilla and R Mauger, 'The UN's New Sustainable Development Agenda and Renewable Energy: The Challenge to Reach SDG7 While Achieving Energy Justice' (2018) 36 J Energy Nat Resour Law 233 <https://doi.org/10.1080/02646811.2017.1377951>.

[13] See, for example, the rising literature on energy justice and the limited focus on storage by non-legal papers. B Tarekegne et al, 'Analysis of Energy Justice and Equity Impacts from Replacing Peaker Plants with Energy Storage' (paper presented at the IEEE Electrical Energy Storage Application and Technologies Conference, Austin, TX, United States, 2022) at 1 <https://doi.org/10.1109/EESAT55007.2022.9998034>.

[14] *Ibid*.

[15] S Baker, S DeVar and S Prakash, *The Energy Justice Workbook* (2019) at 5 <https://iejusa.org/wp-content/uploads/2019/12/the-energy-justice-workbook-2019-web.pdf>.

[16] I Mariuzzo et al, 'Economic Assessment of Multiple Energy Community Participation' (2024) 353 Appl Energy 1 <https://doi.org/10.1016/j.apenergy.2023.122060>.

[17] *Tackling the Climate Crisis at Home and Abroad*, Executive Order no. 14008 (27 January 2021), reprinted in *Federal Register*, vol 86, no 19 (2021),s 223 <https://www.whitehouse.gov/environmentaljustice/justice40/>, and its critique in N Sadasivam, 'Why the White House's Environmental Justice Tool Is Still Disappointing Advocates' *Grist* (27 February 2023). On the limits of legislative texts of constitutional level in addressing 'distributive, procedural and recognition justice,' see L Kaschny, 'Energy Justice and the Principles of Article 194(1) TFEU Governing EU Energy Policy' (2023) 12 Transnat Environ Law 270 <https://doi.org/10.1017/S2047102523000110>.

[18] EASE, *Energy Storage Targets 2030 and 2050: Ensuring Europe's Energy Security in a Renewable Energy System* (2022) <https://ease-storage.eu/wp-content/uploads/2022/06/Energy-Storage-Targets-2030-and-2050-Full-Report.pdf>.

governance, namely, 'overarching principles that can guide lawmakers in sustainably promoting renewable energy storage systems.'[19] Second, notwithstanding a focus on EU law, the article includes a multi-level analysis in light of the knowledge gap on how to embed storage in energy communities as well as the scalability of possible solutions thereto. In this context, the analysis will also refer to global law, which is defined as 'a law of inter-contextuality expressed as inter-legality and materialized through a particular body of legal norms which can be characterized as connectivity norms.'[20] Connectivity norms are meant to facilitate transplantations, namely, 'the extraction, transmission and incorporation of components of meaning, from one legally structured context to another.'[21] At the same time, albeit different, EU law is itself primarily built on connectivity norms.[22] In view of the multi-level analysis, the topic of energy communities is also approached at a global level as community energy.[23]

Finally, this discussion is limited in scope. The storage use that is investigated here is relevant for decarbonizing power systems, in particular, in light of the power decarbonization recommended target by 2050, globally, and by 2040, in the EU.[24] The analysis covers both behind-the-metre storage, which hinges mainly on self-consumption with the possibility to sell excess electricity back to the grid, and front-of-the metre storage, which is to provide grid services (for example, frequency and non-frequency ancillary services and capacity markets) and be sold to varied customers.

II. COMMUNITY ENERGY

It is now clear that the global energy landscape is becoming local. Approximately one decade ago, upon the inception of deglobalization,[25] the World Energy Council (WEC) emphasized how the national agenda was key to solving the 'energy trilemma,' the triple challenge of finding solutions that would simultaneously tackle energy security, energy equity, and environmental sustainability.[26] Particularly, the WEC displayed the gap between policy-makers and industry, pointing to one another as the responsible party to include energy consumers in a dialogue that was to be part of the energy transition.[27] In response to the localization of sustainable development action since the 2015 SDGs, theory and practice have focused on such enabling concepts as energy democracy, justice, and energy commons.[28] The concept of energy communities and community energy is far from univocal.[29] In this context, energy communities can be defined as 'a wide range of collective energy actions that involve

[19] E Colombo, 'Energy Storage Governance in the Asia-Pacific through the Law of the Sea Convention: Exploring Bottlenecks and Enablers of Regulating Offshore Wind Combined with Energy Storage' (2023) 8 Asia-Pacific J Ocean L & Policy 25 <https://doi.org/10.1163/24519391-08010003>.

[20] PF Kjaer, 'Global Law as Inter-contextuality and as Inter-legality' in J Klabbers and G Palombella, eds, *The Challenge of Inter-legality* (2019) 302 at 302ff.

[21] *Ibid* at 303.

[22] *Ibid* at 307.

[23] See section III below.

[24] European Commission, *Securing Our Future Europe's 2040 Climate Target and Path to Climate Neutrality by 2050 Building a Sustainable, Just and Prosperous Society*, Doc COM/2024/63 final (6 February 2024) at 3; see also the European Union's (EU) recommended 2040 target of 90 per cent net greenhouse gas emissions reduction compared to 1990 levels and the decarbonization of power systems shortly after 2040. *Ibid*.

[25] The first signs of deglobalization arose after the 2008 financial crisis. See H James, 'Deglobalization: The Rise of Disembedded Unilateralism' (2018) 10 Annu Rev Financ Econ 219.

[26] World Energy Council, *World Energy Trilemma: Time to Get Real—The Agenda for Change* (2013) at 6.

[27] *Ibid* at 8.

[28] For a helpful overview, see Mariuzzo et al, *supra* note 16 at 2.

[29] S Moroni, V Antoniucci and A Bisello, 'Local Energy Communities and Distributed Generation: Contrasting Perspectives, and Inevitable Policy Trade-Offs, beyond the Apparent Global Consensus' (2019) 11 Sustainability 1 at 2 <https://doi.org/10.3390/su11123493>.

citizens' participation in the energy system.'[30] Similarly, community energy was displayed as 'projects where communities (of place or interest) exhibit a high degree of ownership and control, as well as benefit collectively from the outcomes.'[31]

At the global level, community energy has cut across jurisdictions. Community energy is a growing movement.[32] Citizens bear the brunt of energy crises and can greatly contribute to their solutions through such distributed energy resources as citizen energy communities, renewable energy communities, and, more generally, energy sharing. It was found that government tools supporting community energy fall into four global categories: payment-based, grid access, environmental protection, and community planning and capacity.[33] Within these categories, the most recurrent instruments are feed-in tariffs, grid services, and fiscal incentives.[34] At the regional level, when launching the EU in 2015, the Juncker Commission reiterated the concept that the future of energy would be citizen oriented,[35] and two legislative waves have shaped community energy initiatives. The EU's Clean Energy for all Europeans Package first introduced provisions for renewable energy communities (RECs) and citizens' energy communities (CECs). RECs are defined in the Renewable Energy Directive,[36] while CECs are presented in the Electricity Market Directive.[37] RECs are featured by extra requirements that serve to include only renewable-based generation units and users within a certain geographical proximity, while CECs are bound by fewer restrictions. Importantly, the 'primary purpose' of a REC is to provide environmental, economic, and social community benefits for its members or for the local areas where it operates rather than financial profits.[38]

A second wave emerged following the COVID-19 pandemic at the conjunction of the war in Ukraine, an inflation surge, and an energy price crisis. This second wave was marked by such legislative solutions as European Commission's REPowerEU[39] and Fit for 55 Package[40] as well as the revision of the Electricity Market Directive,[41] which are all aimed to tackle the energy trilemma of energy security, energy equity, and environmental sustainability.

These initiatives will eventually reinforce the model of energy communities.[42] As stipulated in Article 22(3) of the revised Renewable Energy Directive, all EU member states shall conduct a national evaluation of barriers for and potential of RECs within their territories as a starting point to shape enabling policies.[43] In addition, second-generation EU legislation

[30] E Caramizaru and A Uihlein, *Energy Communities: An Overview of Energy and Social Innovation*, Doc JRC119433 (2020) at 7 <https://doi.org/10.2760/180576>.

[31] G Seyfang et al, 'A Thousand Flowers Blooming? An Examination of Community Energy in the UK' (2013) 61 Energy Policy 977 <https://doi.org/10.1016/j.enpol.2013.06.030>.

[32] SJW Klein and S Coffey, 'Building a Sustainable Energy Future, One Community at a Time' (2016) 60 Renew Sustain Energy Rev 867 <https://doi.org/10.1016/j.rser.2016.01.129>.

[33] R Leonhardt et al, 'Advancing Local Energy Transitions: A Global Review of Government Instruments Supporting Community Energy' (2022) 83 Energy Res Soc Sci 1 <https://doi.org/10.1016/j.erss.2021.102350>.

[34] *Ibid*.

[35] European Commission, *A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*, Doc COM (2015) 80 final 2 (2015).

[36] Council Directive (EU) 2018/2001 on the Promotion of the Use of Energy from Renewable Sources (recast), (2018) OJ L328 (Renewable Energy Directive).

[37] Council Directive (EU) 2024/1711 as Regards Improving the Union's Electricity Market Design, (2024) OJ L2024/1711 (Electricity Market Directive).

[38] Renewable Energy Directive, *supra* note 36, art 2(16)(c).

[39] European Commission, *REPowerEU Plan*, Doc COM(2022) 230 final (2022).

[40] European Commission, *Fit for '55: Delivering the EU's 2030 Climate Target on the Way to Climate Neutrality*, Doc COM (2021) 550 final (2021).

[41] Electricity Market Directive, *supra* note 37; Council Regulation (EU) 2024/1747 as Regards Improving the Union's Electricity Market Design, (2024) OJ L2024/1747.

[42] D Vansintjan, S Pappa and F Kriedemann, 'EU Energy Communities Legislation 2.0: An Upwards Trend' *News Blog* (14 March 2024) <https://sustainable-energy-week.ec.europa.eu/news/eu-energy-communities-legislation-20-upwards-trend-2024-03-14_en>.

[43] See guidance for the assessment. <https://www.rescoop.eu/policy/transposition-tracker>.

has clarified that citizen-led initiatives will contribute to a host of activities beyond energy production in small-scale projects, including community heating and cooling, renovations, energy poverty solutions, and large-scale projects. Recognition of the role of energy communities in these larger projects under the revised Renewable Energy Directive was also aimed to enhance public acceptance of the energy transition by involving citizens as fully-fledged actors of change.[44]

The decarbonization and democratization potentials are huge. Pursuant to a recent survey, beyond monetization, the primary motives for establishing energy communities are sustainability and efficiency.[45] Across the EU, citizen-led energy initiatives produce a rough capacity of ten gigawatts of renewable-based heat and electricity.[46] Over the years, to fund these projects, eleven billion euros have been raised, mainly at government and private levels.[47] By 2050, roughly 83 per cent of EU households could be involved, which equates to approximately 187 million households.[48] By 2050, around 45 per cent of EU renewable energy could stem from citizens.[49] EU member states have considerable leeway in interpreting, transposing, and practically applying ambiguous legal terms like 'proximity' and 'primary purpose' and have at times failed to customize EU provisions to the particular roles and interactions between grid operators and RECs in each jurisdiction as well as to establish guidelines for the implementation of energy sharing.[50] While some member states have made strides in transposing provisions into national laws, many lag behind.[51] For example, energy communities can usually feed their electricity into the national grid, but, in many regions, members are unable to share energy among themselves, unless they possess their own grid, such as a local heating network, or reside in the same building or interconnected buildings.[52] Ensuring effective transposition and enforcement of EU rules is crucial to creating 'enabling frameworks' for energy communities to carry out activities on an equal footing with other market players and to promote their development.[53]

Despite such progress, barriers persist, including funding, grid access, and regulatory complexity.[54] In response to these three challenges, the three-point agenda hinges on finance, the power market, and innovation, including policy complexity innovation. The agenda itself can be the starting point for an EU-level strategy for energy communities, which has been shown to be missing.[55]

[44] Vansintjan, Pappa and Kriedemann, *supra* note 42. On the initial conceptualization of energy commons, see B Hoops, 'The Clash of the Energy Commons' (2024) 33 Eur Energy & Environ Law Rev (pre-print).

[45] M Haji Bashi et al, 'A Review and Mapping Exercise of Energy Community Regulatory Challenges in European Member States Based on a Survey of Collective Energy Actors' (2023) 172 Renew Sustain Energy Rev 1 <https://doi.org/10.1016/j.rser.2022.113055>.

[46] VJ Schwanitz et al, 'Statistical Evidence for the Contribution of Citizen-Led Initiatives and Projects to the Energy Transition in Europe' (2023) 13 Sci Rep 1342 at 1345.

[47] *Ibid.*

[48] B Kampman, J Blommerde and M Afman, *The Potential of Energy Citizens in the European Union* (2016).

[49] *Ibid* at 25.

[50] M Krug et al, 'Implementing European Union Provisions and Enabling Frameworks for Renewable Energy Communities in Nine Countries: Progress, Delays, and Gaps' (2023) 15 Sustainability 1 at 25 <https://doi.org/10.3390/su15118861>.

[51] See the 'Transposition Tracker,' *REScoop.eu* <https://www.rescoop.eu/policy/transposition-tracker/rec-cec-definitions>.

[52] B Hoops, 'EU Directives on the Internal Governance of Energy Communities and Their Exclusionary Effects' (2024) 17 J World Energy Law Bus 147 <https://doi.org/10.1093/jwelb/jwae001>.

[53] The mandate for states to shape 'enabling frameworks' was already enshrined in the Renewable Energy Directive, *supra* note 36, art 22(5).

[54] Vansintjan, Pappa and Kriedemann, *supra* note 42.

[55] *Ibid.*

III. THE ROLE OF STORAGE IN COMMUNITY ENERGY: FOCUSING ON THE EU

This section investigates the role of renewable energy storage in energy communities, which has been explored only recently in engineering and other types of hard science articles rather than from the viewpoint of legal frameworks.[56] Beyond decarbonization and democratization, energy communities are also a byword for decentralization. At a more global level, renewable energy communities are presented as the harbinger of future networks, where distributed generation sources complement large central generating stations.[57] In distributed energy resources (DERs), the role of renewable energy storage is key. The transmission and distribution systems have been designed to 'connect and forget' the end loads.[58] Further, at the transmission and distribution levels, energy has not been designed as 'storageable.'[59] Thus, the expectation is for the end users to be able to rely on either self- or locally produced energy within energy communities equipped with storage systems and energy-sharing policies among users.[60]

IRENA's statistics on community energy have not yet been generated .[61] Nonetheless, total off-grid renewable energy has doubled between 2014 and 2023.[62] Energy communities, however, can be hindered by a lack of access to the grid, which is also due to the costs of connection and the technical requirements for this connection, which are designed for various utilities.[63] The impacts can be detrimental—without access, for instance, energy communities would not be able to sell excess electricity to the grid. At the EU level, energy communities have existed before they were recognized in EU legislation, but energy transition requires them to be scaled up.[64] However, key barriers to prosumers and energy communities have also multiplied due to how the EU's regulatory frameworks have been implemented differently across the various member states.[65]

According to the common definition in the Electricity Market Directive, energy storage in power systems is defined as either: (i) postponing the consumption of electricity to a later time than its generation; or (ii) converting electrical energy into a storable form, storing it, and later reconverting it into electrical energy or utilizing it as a different energy carrier.[66] A few pieces of EU legislation can support the storage of renewable energy. Under the Governance Regulation, storage shall be included in national energy and climate plans in order to ramp up the flexibility of the energy system and ensure non-discriminatory participation in the energy markets.[67] Notably, storage shall be included in the integrated progress reports on energy security and the internal energy market respectively.[68] Article 3(1) of

[56] See, e.g., R Trevisan, E Ghiani and F Pilo, 'Renewable Energy Communities in Positive Energy Districts: A Governance and Realisation Framework in Compliance with the Italian Regulation' (2023) 6 Smart Cities 563 <https://doi.org/10.3390/smartcities6010026>.

[57] *Ibid*.

[58] *Ibid*.

[59] *Ibid*.

[60] *Ibid*.

[61] IRENA, *supra* note 8.

[62] *Ibid* at 45.

[63] A Wainer, D Petrovics and N van der Grijp, 'The Grid Access of Energy Communities: A Comparison of Power Grid Governance in France and Germany' (2022) 170 Energy Policy 1.

[64] J Lowitzsch, CE Hoicka and FJ van Tulder, 'Renewable Energy Communities under the 2019 European Clean Energy Package: Governance Model for the Energy Clusters of the Future?' (2020) 122 Renew Sustain Energy Rev 1 at 2.

[65] I Campos et al, 'Regulatory Challenges and Opportunities for Collective Renewable Energy Prosumers in the EU' (2020) 138 Energy Policy 1.

[66] Electricity Market Directive, *supra* note 37, art 2(59).

[67] Council Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action, (2018) OJ L328, art 22(1)(d).

[68] *Ibid*, arts 22(1)(d), 23(1)(e); see also art 25(1)(c).

the Electricity Market Directive on the common rules for the internal market for electricity prescribes that member states shall ensure that their national law does not unduly hamper investments into variable and flexible energy generation and energy storage.[69]

Further, members states shall lay down criteria for the granting of authorizations for generating capacity in their territory by considering energy storage (Article 8(2)(l)) When active consumers, such as renewable energy prosumers, own an energy storage facility, they should be subject to fair treatment (Article 15(5)). The revised Renewable Energy Directive provides for renewable energy communities the right to consume, store, or sell renewable energy as independent legal entities on an equal footing with market actors.[70] Still, neither directive is accompanied by more specific guidance on how the regulatory frameworks of member states can effectively facilitate prosumers' investments in storing technology for renewable energy. In Europe, pumped hydro storage, which is an energy storage system technology leveraging two water reservoirs at different elevations and is not easily deployed by prosumers, is the main system of energy storage, while other technologies—most notably, batteries—depend on varying support schemes and policies across the member states,[71] short of a strategy on energy storage. Notwithstanding the supportive role for storage and circularity in the EU's battery value chain,[72] even the second legislation wave has failed to address storage jointly within the energy communities to better support and incentivize its role for community energy.[73]

More recent initiatives include the 2023 proposal for a new Electricity Market Directive, which is currently enacted[74] and has been called the 'strongest legislative language' in support of energy storage to date and a de facto 'energy storage strategy.'[75] In particular, the Electricity Market Directive integrates the approach to storage with the need for demand response and mandates national energy authorities to assess system needs for both demand response and storage under regular flexibility assessments. Such flexibility assessments should 'take into account all existing and planned investments (including existing assets that are not yet connected to the grid) on sources of flexibility such as flexible electricity generation, interconnectors, demand side response, energy storage or the production of renewable fuels, in view of the need to decarbonise the energy system.'[76] While a storage target is lacking for the EU as a whole, the member states should define a national objective for non-fossil

[69] *Ibid.*

[70] Renewable Energy Directive, *supra* note 36, art 22.

[71] Directorate-General for Energy Internal Energy Market, *Study on Energy Storage: Contribution to the Security of the Electricity Supply in Europe* (2020) at 26.

[72] Council Regulation (EU) 2023/1542 Concerning Batteries and Waste Batteries, (2023) OJ L191/1.

[73] See, e.g., European Commission, *Powering a Climate-Neutral Economy: An EU Strategy for Energy System Integration*, Doc COM(2020) 299 final (2020); European Commission, A Hydrogen Strategy for a Climate-Neutral Europe for the Support for Energy Storage in System Integration and Sector Coupling, Doc COM(2020) 301 final (2020); see also Council Directive (EU) 2023/1791 on Energy Efficiency, (2023) OJ L231, arts 1(1), 22(3)(a), 29(4), 35(4). See also the revised Energy Performance of Buildings Directive, which is still to be published at the time of writing, and the proposed directive and regulation on the internal markets for renewable and natural gases as well as for hydrogen, which aims to promote the utilization of energy carriers conducive to storage and flexibility, including hydrogen, hydrogen storage, and renewable methane. Council Directive (EU) 2024/1788 on Common Rules for the Internal Markets for Renewable Gas, Natural Gas and Hydrogen, (2024) OJ L2024/1788 (Gas Package Directive); see also Council Regulation (EU) 2024/1789 on the Internal Markets for Renewable Gas, Natural Gas and Hydrogen, (2024) OJ L2024/1789. On the revision of the Energy Taxation Directive, see the discussion earlier in this article.

[74] Electricity Market Directive, *supra* note 37.

[75] A Colthorpe, 'European Commission's "Raised Ambition" for Energy Storage in Electricity Market Design Welcomed, with Caveats' *Energy Storage News* (15 March 2023) <https://www.energy-storage.news/european-commissions-raised-ambition-for-energy-storage-in-electricity-market-design-welcomed-with-caveats/>.

[76] Electricity Market Directive, *supra* note 37, preambular para 23.

flexibility, such as demand-side response and storage, which needs to be reflected in their integrated national energy and climate plans.[77]

On the same day of the Electricity Market Directive's publication in March 2023, the European Commission published two documents devoted to energy storage, which are not yet binding: (i) the Commission's 2023 recommendation on energy storage, which underpins a decarbonized and secure EU energy system,[78] and the related 2023 staff document,[79] which adds to the Commission's 2017 staff working document on the role of energy storage in the context of the Clean Energy for all Europeans package;[80] and (ii) the European Parliament's resolution on a comprehensive European approach to energy storage.[81] By solely describing the state of the art on storage, while emphasizing the need for the member states to be in the driving seat in supporting storage, these documents lack an integrated approach as they are not poised to embed storage in energy communities. Further, they are not binding and are lacking any means to incentivize energy storage.

More integrated policies for storage and energy communities, however, have emerged from the Gas and Hydrogen Markets package. In particular, the Electricity Market Directive establishes a common framework for the decarbonization of the markets for gas in order to contribute to the achievement of the EU's climate and energy targets. In doing so, the directive establishes common rules for the transmission, distribution, supply, and storage of natural gas and hydrogen using the natural gas system. Although it is contained in a preambular paragraph only, the directive explicitly mentions energy communities as enablers of renewable gas adoption.[82]

Beyond the power regulation sector, access to renewable energy sources through energy storage and prosumers, which is set out in the EU's Taxonomy Regulation, would substantially contribute to climate mitigation.[83] Still, energy communities face varying policies that do not account for the public's role in their investment. More broadly, the problem lies with the inadequate acknowledgement of the system's value of storage in power markets, leading to what is commonly referred to as 'missing money.'[84] Missing money occurs when market revenues fail to adequately compensate investors, rendering storage projects financially unviable and consequently hindering the optimal deployment of storage solutions. While public funding on both energy communities and storage systems are rising, and can at times be cumulated,[85] the support landscape is quite limited and should go beyond public funding. Access to renewable energy sources through energy storage and prosumers may not 'even be necessary from the point of view of energy security and in light of environmental and social concerns,' but it should foster innovation and energy democracy in the highly regulated energy sector.[86]

[77] *Ibid*.

[78] Commission Recommendation 2023/C 103/01 C/2023/1729 on Energy Storage: Underpinning a Decarbonised and Secure EU Energy System, (2023)OJ C103 at 1–5.

[79] European Commission, *Energy Storage: Underpinning a Decarbonised and Secure EU Energy System*, Staff Working Doc SWD(2023) 57 final (14 March 2023) (Staff Working Document on Storage).

[80] European Commission, *Energy Storage – The Role of Electricity*, Staff Working Document, SWD(2017) 61 final (1 February 2017).

[81] European Parliament, *Resolution on a Comprehensive European Approach to Energy Storage*, Doc 2019/2189(INI) (10 July 2020) <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020IP0198>.

[82] Gas Package Directive, *supra* note 73, preambular paras 38, 55.

[83] Council Regulation (EU) 2020/852 on the Establishment of a Framework to Facilitate Sustainable Investment, (2020) OJ L198, art 10(1)(a).

[84] IRENA, *Electricity Storage Valuation Framework: Assessing System Value and Ensuring Project Viability* (2020) at 13.

[85] See Italian Regulation Allowing for Limited Public Aid Cumulation, Renewable Energy Communities, Decree no. 414/2023, art 6 (Italian REC Decree).

[86] On both points, see European Economic and Social Committee, *Prosumer Energy and Prosumer Power Cooperatives: Opportunities and Challenges in the EU Countries*, Doc 2017/C 034/07 (2017) at paras 1.1, 3.2.

IV. A THREE-POINT INTEGRATIVE AGENDA

1. Introduction

The previous sections have revealed how energy communities pose both challenges and opportunities for energy systems. Although energy communities can be social innovators in the decarbonization landscape, key barriers to their deployment and financing are of a regulatory nature, especially for the integration of energy storage solutions. Because of the complexity of regulating renewable energy storage, the following three-point agenda is meant to better embed storage in energy communities' regulatory frameworks at the EU level. In this context, the methodological choice of focusing on how to incentivize energy communities is due to the focus in some jurisdictions, in particular, on the need to scale up energy communities' access to finance and financial benefits.[87] In the absence of a comprehensive EU storage bill and EU-wide storage targets, this article advocates for a three-point agenda aimed at leveraging renewable energy storage opportunities in energy communities through finance, power, and innovation packages.

2. Finance

Notwithstanding the efficient leverages that equity offers, debt is the main form of raising capital for both storage projects and energy communities. As a result of the high capital expenditures and dependencies on geopolitical equilibria, most storage projects are not attractive for risk-averse investors.[88] At the same time, equity financing remains an untapped opportunity for financing energy communities. The latter may be perceived as an overly complex—and relatively small—market.[89] Financing issues are compounded by a great deal of uncertainty about the availability and cost of storage options as well as the implementation and eligibility of funding schemes.[90]

In order to incentivize access to finance for storage in energy communities, at least three regulatory avenues must be envisaged. First, at the institutional level, energy communities require an ecosystem of green banks, which are public lending institutions designed to use limited public capital to leverage greater private investment.[91] Globally, green banking contributes to a welfare economy by integrating environmental and ecological factors into the assessment of asset quality and long-term return rates.[92] Compared to commercial and institutional banks, it does not exclude small markets as deals can be structured through credit enhancement, project aggregation, and securitization. Accordingly, short of the establishment of the proposed EU Regional Green Bank,[93] energy communities deserve access to finance from institutions such as the European Investment Bank (EIB) and European Local Energy Assistance (ELENA), which are currently focused on large markets.[94] This bias

[87] See, e.g., Renewable Energy Directive, *supra* note 36, art 22 (4)(g), and incentivizing schemes in Italy, such as the Italian REC Decree, *supra* note 85; see also 'Funding for Energy Efficiency and Electrification Upgrades for Local Governments,' *Australia Government* <https://business.gov.au/grants-and-programs/community-energy-upgrades-fund-round-1>.

[88] Staff Working Document on Storage, *supra* note 79 at 24.

[89] On both points, see 'Investors Dialogue on Energy, WG Services and Prosumers,' Issue Paper no. 11 (paper presented at the Discussion on Quasi-Equity financing Quasi-equity scheme for Services and Prosumers, March 2024) at 4.

[90] K Neuhoff, N May and JC Richstein, 'Financing Renewables in the Age of Falling Technology Costs' (2022) 70 Res Energy Econ 1 at 2<https://doi.org/10.1016/j.reseneeco.2022.101330>.

[91] J Schub, 'Green Banks: Growing Clean Energy Markets by Leveraging Private Investment with Public Financing' (2016) 21 J Struct Finance 26.

[92] R Miah et al, 'Innovative Policy Approach to Environmental Resource Management through Green Banking Activities' (2023) 13 Am J Econ 35.

[93] E Colombo, 'Europe Needs a Regional Green Bank to Fulfil Its Green Deal and Match the U.S' *Energy Post* (20 January 2023) <https://energypost.eu/europe-needs-a-regional-green-bank-to-fulfil-its-green-deal-and-match-the-u-s/>.

[94] E Colombo, 'The European Make-It or Break-It Green Moment' *Faculty of Law, University of Oslo* (15 February 2021).

hinders fair participation for prosumers in the electricity market. Additionally, there is a notable gender gap in prosumerism,[95] with women facing barriers to financial access.[96] The EIB and ELENA should not only offer financial vehicles to prosumers but also implement measures to support women, such as preferential rates. Furthermore, the Eurosystem, which comprises the European Central Bank and nineteen Euro-area central banks, should reassess their investment policies, especially for sustainable assets, which would boost the practical implications of the Taxonomy Regulation for collective sustainable investments.[97]

Second, content wise, in order to maximize finance at the project level, quasi-equity schemes should be promoted through policy signals. Quasi-equity investment refers to a form of financing where the pricing is linked to the company's performance, carrying higher risk than senior debt and lower risk than common equity. Quasi-equity investments may take various structures, such as subordinated debt, mezzanine debt, or preferred equity, and, in certain instances, they can be convertible into equity.[98] As target beneficiaries of quasi-equity, energy communities would access funds over a relatively long time frame (for example, thirty months or longer), ensuring the necessary flexibility to scale up operations and provide a long maturity period to generate returns before the loan must be repaid. One of the benefits of quasi-equity, which is a form of venture debt, is its flexibility compared to traditional debt and its non-dilutive nature, meaning that energy communities do not need to give up a portion of their ownership in exchange for the financing, unlike with equity financing.

Third, green bonds can offer strong incentives for financial entities to enable capital in energy communities.[99] In particular, the EU's Green Bond Regulation is a world's first by setting the first regional green bond standard worldwide. In addition to the green bond label, the regulation should be coupled with EU-coordinated incentives (for example, taxation and investment incentives) that are not currently present. More broadly, the EU's proposed Affordable Energy Action Plan may put energy communities on an equal footing with non-community energy projects. In fact, the plan aims to reduce energy costs for citizens, businesses, industries, and communities across the EU. A broader Tripartite Contract for Affordable Energy is meant to unite the public sector, energy producers, and energy-consuming industries to foster a favourable investment environment and support a competitive industrial sector within the EU.[100] Energy communities, however, should be formally integrated into the Tripartite Contract for Affordable Energy to ensure that they are eligible for investment-facilitating measures as well as for tenders that prioritize social criteria rather than only price and environmental criteria.[101]

Overall, by accessing capital, energy communities will be better able to build economies of scale and sign economically attractive power purchase agreements with large off-takers,

[95] *Ibid*.

[96] E Pavlova and S Gvetadze, 'Female Access to Finance: A Survey of Literature,' Working Paper no. 2023/87 (2023) at iv <https://www.eif.org/news_centre/publications/eif_working_paper_2023_87.pdf>.

[97] Colombo, *supra* note 94.

[98] Quasi-equity investments are defined in Article 2 of the General Block Exemption Regulation. Commission Regulation (EU) 651/2014 Declaring Certain Categories of Aid Compatible with the Internal Market in Application of Articles 107 and 108 of the Treaty (17 June 2014).

[99] Y Ning et al, 'Green Bond as a New Determinant of Sustainable Green Financing, Energy Efficiency Investment, and Economic Growth: A Global Perspective' (2023) 30 Environ Sci Pollut Res 61324 <https://doi.org/10.1007/s11356-021-18454-7>.

[100] European Commission, *Action Plan for Affordable Energy: Unlocking the True Value of Our Energy Union to Secure Affordable, Efficient and Clean Energy for All Europeans*, Doc COM(2025) 79 final (26 February 2025).

[101] 'The Diamond Hidden in the Rough? Energy Communities and the EU's Action Plan on Affordable Energy,' *ResCoop* (22 February 2025).

which has so far been prevented by their small size.[102] Such measures will need to be coupled with existing grant-based approaches, including 'energy community facilities' to provide cascade funding to energy community projects.[103] Nevertheless, short of power market interventions, such as allowing for wider revenue stacking, discussed earlier in this article, the embedding of energy storage in community energy systems through financial vehicles will still be limited.

3. Power Market

In order to incentivize energy communities' participation in power markets with storage systems, at least three reforms have been envisaged. First, all services that energy communities provide the grid with should be compensated through wide revenue stacking, including storage. In principle, in the EU, electricity market design has made it possible for energy storage solutions to participate in all electricity markets, thus providing the basis for wide revenue stacking.[104] Such a rule is based on the assumption that all services provided should be valued and monetized properly, not only for fairness reasons but also to avoid the unduly prolongation of an investment's payback.[105] The different markets that would be available to energy communities for storage include the capacity for peak demand, arbitrage, ancillary services and congestion management, transmission and distribution replacement, network deferral, and black-start capability.

However, in the EU, local flexibility markets are far from being established, which will hamper the remuneration of non-frequency ancillary services, including both short-timescale services (for example, fast-frequency response, black-start capabilities, voltage control and inertia) and long-term services (for example, energy reliability and deferrals of network upgrades).[106] Although the EU's revenue-stacking policy is long overdue, its complexity should not be understated as it would require a model, or algorithm, that schedules the considered storage asset in a way that best satisfies the purpose of the energy storage system, forecasting system dynamics and market prices in the future.[107] Revenue stacking also requires transparency as it would only be possible to achieve if network operators set up transparent flexibility markets for all interested parties.[108]

Second, a level playing field for participating in the power markets should be achieved. Capacity mechanisms consist of the remuneration of power plants for installed capacity, on top of regular revenues from sales, to ensure sufficient electricity generation infrastructure.[109] Many countries allow renewables to participate in capacity mechanisms, but,

[102] European Commission, *Guidance to Member States on Good Practices to Speed Up Permit-Granting Procedures for Renewable Energy Projects and on Facilitating Power Purchase Agreements Accompanying the Document Commission Recommendation on Speeding Up Permit-Granting Procedures for Renewable Energy Projects and Facilitating Power Purchase Agreements*, Staff Working Document, Doc SWD/2022/0149 final (18 May 2022) at 41 9 (Staff Working Document on Good Practices).

[103] See, e.g., 'Legislative Train: EU Solar Energy Strategy' *European Parliament* (March 2024) at 1 <https://www.europarl.europa.eu/legislative-train/carriage/eu-solar-strategy/report?sid=7901>; 'Biden-Harris Administration Announces $20 Billion in Grants to Mobilize Private Capital and Deliver Clean Energy and Climate Solutions to Communities across America' *Environmental Protection Agency Press Office* (4 April 2024) <https://www.epa.gov/newsreleases/biden-harris-administration-announces-20-billion-grants-mobilize-private-capital-and-0>.

[104] For the EU, see Staff Working Document on Storage, *supra* note 79 at 25.

[105] *Ibid*.

[106] *Ibid* at 26

[107] See also J Hjalmarsson, K Thomas and C Boström, 'Service Stacking Using Energy Storage Systems for Grid Applications: A Review' (2023) 60 J Energy Storage 1 <https://doi.org/10.1016/j.est.2023.106639>.

[108] D Parra and R Mauger, 'A New Dawn for Energy Storage: An Interdisciplinary Legal and Techno-Economic Analysis of the New EU Legal Framework' (2022) 171 Energy Policy 1.

[109] M Kozlova and I Overland, 'Combining Capacity Mechanisms and Renewable Energy Support: A Review of the International Experience' (2022) 155 Renew Sustain Energy Rev 1 <https://doi.org/10.1016/j.rser.2021.111878>.

historically, energy storage has been remunerated through capacity mechanisms limitedly because policy design does not properly incentivize it.[110]

In the EU, for instance, the capacity market carbon cap is currently 550 gigawatts per kilowatt hour for new power plants,[111] which includes most gas plants and excludes only coal, diesel, and some older gas plants, thus limiting the decarbonization of the capacity markets. A gradual decrease of such a cap, coupled with system adequacy evaluations, would incentivize the participation of renewables coupled with storage as well as the differentiation of renewable energy sources. In a country without a sufficient amount of solar power, it would shift investment incentives from solar to wind and hydropower, thus improving system reliability.[112] In the future, capacity mechanisms may prove crucial for developing long-duration energy storage.[113] Further, a prohibition on double taxation is due. Double taxation often applies to storage providers for both injecting and withdrawing electricity to and from the grid, although such flexibility services per se require the double role of both generating and consuming electricity. In the EU, double taxation is often one of the main obstacles for storage deployment and should be more clearly prohibited and strictly monitored.[114] In addition, double taxation prohibition should be accompanied by signals in network tariffs, such as lower tariffs or nodal pricing.[115]

Third, remuneration schemes for utilities should be changed in order to be tied to positive incentives for energy transition, such as the integration of renewables and renewable energy storage.[116] Further, remuneration schemes should be aligned with an EU baseline of procedural rules that are specific to storage[117] and energy communities, considering that, in the EU, some energy communities happen to receive priority treatment in their applications for connections to the grid, approval of environmental conditions, and production licensing, such as is happening in Greece.[118] Similarly, in Ireland, energy communities can apply for grid connection before obtaining a planning permission.[119]

4. Innovation

Energy communities offer ample opportunities for knowledge development across disciplines, including technology. Their operations entail high-tech activities encompassing cybersecurity, communication systems, and artificial intelligence to optimize self-consumption performance. [120] In particular, decarbonized power systems should be coupled also with decentralized prosumers, deploying their own storage technologies, with lower energy costs and increased flexibility.[121] Energy communities, however, are not presently configured as resources for system management. Currently, there are limited incentives for energy communities to engage in system balancing in the distribution network. So far, energy communities

[110] Staff Working Document on Storage, *supra* note 79 at 32.

[111] On the capacity market, see Council Regulation (EU) 2019/943 on the Internal Market for Electricity (recast), (2019) OJ L158 at 54–124, art 22.

[112] Kozlova and Overland, *supra* note 109 at 9.

[113] Staff Working Document on Storage, *supra* note 79 at 32.

[114] Energy Transition Expertise Centre, *Study on Energy Storage* (2022) <https://data.europa.eu/doi/10.2833/333409>. On the disfunction of injection and withdrawing charges applying to prosumers, see Staff Working Document on Storage, *supra* note 79 at 28.

[115] Staff Working Document on Storage, *supra* note 79 at 27.

[116] RL Kauffman, 'Kauffman on REV: Creating a 21st-Century Grid with Clear Price Signals, Utility Incentives and Collaboration' *Sepapower* (23 February 2017).

[117] Staff Working Document on Storage, *supra* note 79 at 17, 28.

[118] Staff Working Document on Good Practices, *supra* note 102 at 8.

[119] *Ibid* at 9.

[120] ZD Grève et al, 'Machine Learning Techniques for Improving Self-Consumption in Renewable Energy Communities' (2020) 13 Energies 1.

[121] See M Child et al, 'Flexible Electricity Generation, Grid Exchange and Storage for the Transition to a 100% Renewable Energy System in Europe' (2019) 139 Renew Energy 80 at 81, 83, 87, 92.

do not equal DERs as DERs are characterized by the capability—rather than the mere potential—to support the management of renewable-based energy systems.[122] Supporting energy communities as DERs would thus require grid overhauls for them to be fully integrated into the electricity network.[123] At least three reforms can be envisaged.

First, sufficient focus should be devoted to peer-to-peer energy sharing.[124] When optimally designed, it has been found that peer-to-peer energy sharing can provide win-win economic benefits to all related stakeholders, including aggregators with access to DERs.[125] In particular, peer-to-peer energy sharing can be enabled by recent advances in artificial intelligence, machine learning, and the Internet of Things to improve system efficiency, optimize energy storage capacity, step up renewable penetration, and mitigate stressed grid power, together with voltage support and congestion management for the local power grid.[126] Second, and connected to the first point, while public funding has so far focused on batteries and pumped hydro storage,[127] energy communities should be incentivized to scale up the deployment of distributed energy storage, coupled with innovation technology for storage system optimization.

Third, innovation should include legal innovation, in particular, to support new types of storage in energy communities. Green hydrogen can be an example in this sense. Notwithstanding the EU's relatively advanced regulatory frameworks on hydrogen and derivatives, the EU is missing a legal framework for energy communities in the context of the hydrogen transition. In particular, given the role of green hydrogen for long duration storage purposes, the missed embedding of green hydrogen in energy communities should not be easily dismissed. Present grant programs should consider existing scientific research—for instance, on solar hydrogen energy communities, which produces green hydrogen by electrolysis fed by solar panels[128]—as well as technical studies where energy communities are providing hybrid configuration combining photovoltaic production, electrolytic hydrogen production, and hydrogen storage.[129]

V. CONCLUSIONS

This article has delved into strategies for enhancing the scalability of renewable energy storage within energy communities. In the absence of a comprehensive EU storage bill and EU-wide storage targets, this article advocates for a three-point agenda aimed at leveraging existing regulatory opportunities through finance, power, and innovation packages. Distinct geographical, institutional, and policy contexts stimulate diversity, rather than conformity,

[122] P Hansen and J Barnes, 'Distributed Energy Resources and Energy Communities: Exploring a Systems Engineering View of an Emerging Phenomenon' *Newcomers Project* (2021) <https://ora.ox.ac.uk/objects/uuid:eb22f171-593c-412a-983b-a9f6d3e67a10>.

[123] *Ibid.*

[124] On energy sharing in energy communities being more than just energy supply, see L Diestelmeier and V Cappelli, 'Conceptualizing "Energy Sharing" as an Activity of "Energy Communities" under EU Law: Towards Social Benefits for Consumers?' (2023) 12 J Eur Consum Mark Law 15.

[125] Y Zhou and PD Lund, 'Peer-to-Peer Energy Sharing and Trading of Renewable Energy in Smart Communities: Trading Pricing Models, Decision-Making and Agent-Based Collaboration' (2023) 207 Renew Energy 177 <https://doi.org/10.1016/j.renene.2023.02.125>.

[126] *Ibid.*

[127] Staff Working Document on Storage, *supra* note 79 at 20.

[128] B Nastasi and S Mazzoni, 'Renewable Hydrogen Energy Communities Layouts towards Off-Grid Operation' (2023) 291 Energy Convers Manag 1 <https://iris.uniroma1.it/bitstream/11573/1684671/3/Nastasi_Renewable%20Hydrogen_2023.pdf>.

[129] On two studies launched by ENGIE on hydrogen communities in France, see 'Pioneering Hydrogen-Powered Local Energy Communities' *ENGIE* <https://innovation.engie.com/en/news/news/research-and-innovation/pioneering-hydrogen-powered-local-energy-communities/29167>.

across energy communities.[130] However, the proposed reform packages can be considered part of the ecosystem of high-level conditions under which energy communities can operate.[131] Future research may consider how to integrate the proposed reform packages in an official reform document, be it a storage bill or a guidance instrument. At a preliminary level, it seems proper to consider that any reform document would need to adopt a multi-instrumental approach, which 'can create a web of regulation that is more resilient and effective than its individual constituents.'[132] Resilience and effectiveness are required not only to keep energy prices down but also to make the grid more democratic and the transition transformative, transforming community energy into a climate opportunity during and in the aftermath of energy crises.

In addition, integration across finance, power, and innovation reform packages can be facilitated by the overarching concept of polycentric energy governance, where legislation not only enhances the standing and legitimacy of community energy as a form of citizen-oriented future but also integrates this recognition with the creation of financially viable business models.[133] Because of the public role of their investments, energy communities deploying renewable energy storage require regulatory support. Regulation through strong institutions should not be comprehensive nor micro-managing. As for the mechanisms that are proposed here, they would be able to 'crowd in' private regulation and incentives to increase energy justice of and in energy systems. It would also add the key dimensions of SDG 16 (peace, justice, and strong institutions) as part and parcel of any community energy storage strategy, although environmental and energy dimensions have little to no role across SDG 16's targets and indicators.[134]

Finally, the future of energy justice depends on the regulation of community energy storage as a complex socio-technical system.[135] Notwithstanding the technological, economic, and societal challenges of integrating community energy storage in today's largely centralized energy systems, embedding renewable energy storage in energy communities has the potential of increasing sustainable energy democracy, a system where decentralized energy resources allow for the fair distribution of burdens and benefits.[136]

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[130] M Koltunov et al, 'Mapping of Energy Communities in Europe: Status Quo and Review of Existing Classifications' (2023) 15 Sustainability 1 <https://doi.org/10.3390/su15108201.

[131] D Petrovics, D Huitema and A Jordan, 'Polycentric Energy Governance: Under What Conditions Do Energy Communities Scale?' (2022) 32 Environ Policy Gov 438 <https://doi.org/10.1002/eet.1989>.

[132] N Gunningham, 'A Quiet Revolution: Central Banks, Financial Regulators, and Climate Finance' (2020) 12 Sustainability 1 <https://doi.org/10.3390/su12229596>.

[133] Petrovics, Huitema and Jordan, *supra* note 131 at 447.

[134] S Amaruzaman et al, 'Polycentric Environmental Governance to Achieving SDG 16: Evidence from Southeast Asia and Eastern Africa' (2022) 13 Forests 68 <https://doi.org/10.3390/f13010068>.

[135] B Prasad Koirala, E van Oost and H van der Windt, 'Community Energy Storage: A Responsible Innovation towards a Sustainable Energy System?' (2018) 231 Applied Energy 570.

[136] R Fleming, K Huhta and L Reins, 'What Is Sustainable Energy Democracy in Law?' in R Fleming, K Huhta and L Reins, eds, *Sustainable Energy Democracy and the Law* (2021) 3.

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